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LATHAM & WATKINS

ATTORNEYS AT LAW
701 "B" STREET, SUITE 2100
SAN DIEGO, CALIFORNIA 92101-8197
TELEPHONE (619) 236-1234
FAX (619) 696-7419
TLX 590778
ELN 62793276

PAUL R. WATKINS (1899-1973)
DANA LATHAM (1898-1974)

CHICAGO OFFICE
SEARS TOWER, SUITE 5800
CHICAGO, ILLINOIS 60606
TELEPHONE (312) 876-7700
FAX (312) 993-9767

LONDON OFFICE
12 COPTHALL AVENUE
LONDON EC2R 7DH ENGLAND
TELEPHONE 071-374 4444
FAX 071-374 4460

LOS ANGELES OFFICE
633 WEST FIFTH STREET, SUITE 4000
LOS ANGELES, CALIFORNIA 90071-2007
TELEPHONE (213) 485-1234
FAX (213) 891-8763

NEW YORK OFFICE
885 THIRD AVENUE, SUITE 1000
NEW YORK, NEW YORK 10022-4802
TELEPHONE (212) 906-1200
FAX (212) 751-4864

ORANGE COUNTY OFFICE
650 TOWN CENTER DRIVE, SUITE 2000
COSTA MESA, CALIFORNIA 92626-1918
TELEPHONE (714) 540-1235
FAX (714) 755-8290

SAN FRANCISCO OFFICE
580 CALIFORNIA STREET, SUITE 500
SAN FRANCISCO, CA 94104
TELEPHONE (415) 391-0600
FAX (415) 395-8095

WASHINGTON, D.C. OFFICE
1001 PENNSYLVANIA AVE., N.W., SUITE 1300
WASHINGTON, D.C. 20004-2505
TELEPHONE (202) 637-2200
FAX (202) 637-2201

February 22, 1991

BY FEDERAL EXPRESS

Brad Shipley, On-Scene Coordinator
U.S. Environmental Protection Agency, Region 9
75 Hawthorne Street (H-8-3)
San Francisco, California 94105

Re: Comments on EPA Amended Order No. 90-22 and its Underlying Administrative Record

Dear Mr. Shipley:

We are writing on behalf of Montrose Chemical Corporation of California ("Montrose") in response to a "public notice" of a "public review and comment period" on "supplemental material" to the administrative record for the United Heckathorn/Levin Richmond Terminal Removal Site (the "Site"). Pursuant to the "public notice" received by Montrose, comments may be sent to the United States Environmental Protection Agency ("EPA") through February 25, 1991.

On January 11, 1991, we responded on behalf of Montrose to a "public notice" of a "public review and comment period" on the administrative record for the Site. That public notice invited comments on the administrative record supporting the issuance of EPA Order No. 90-22. Accordingly, our comments dated January 11, 1991 related to EPA Order No. 90-22 and its underlying administrative record.

The "public notice" of a "public review and comment period" on the "supplemental material" of the administrative record for the Site announces that the EPA has issued Order No. 90-22 (the "Original Order") <u>and</u> Amended Order No. 90-22 (the "Amended Order"). It is presumed that the entire administrative record is intended to support the Amended Order. This public notice, however, invites comments "on the supplemental material only." Because Montrose has not previously been afforded an opportunity to comment upon the Amended Order, we hereby submit comments on Amended Order No. 90-22 in reference to the entire administrative record, including specific references to the supplemental material.

In light of a letter dated January 31, 1991 from Jeff Zelikson, Director of EPA's Hazardous Waste Management Division, addressed to Mr. Frank Bachman at Montrose Chemical Corporation [sic] (the "Zelikson January 31, 1991 letter"), some of the objections and comments made herein may appear moot. The Zelikson January 31, 1991 letter, attached hereto as Exhibit 1, states that it "officially suspends EPA Amended Order No. 90-22 requirements for removal of contaminated sediments below mean low water in the Lauritzen Canal, as provided in Section V.E.4." Exhibit 1 at 3. The letter announces that in light of comments and technical information received by the EPA, "[t]he OSC determined that the time frame for sediment removal, as specified in the Amended Order, should be altered" and the OSC has determined that such action is "non-time critical." Exhibit 1 at 2. Consequently, a "formal Engineering Evaluation/Cost Analysis (EE/CA) report [shall] be completed prior to implementation of the chosen remedy." Exhibit 1 at 2. Nevertheless, Montrose includes objections and comments pertaining to suspended portions of the Amended Order to ensure a complete record for EPA evaluation and to fully preserve Montrose's rights if the EPA decides in the future to initiate an enforcement action.

Montrose's objections must be considered in light of the history of the Site. The Heckathorn Companies operated a pesticide-formulating facility at the Site from 1948 through 1965. Montrose's involvement with the Site ended no later than 1965. The State of California (the "State") discovered contamination at the Site in 1980. Since 1980, Levin Enterprises (formerly, Levin Metals Corporation), the owner of the Site, and Levin Richmond Terminal Corporation, the operator of the Site (collectively "Levin") have been negotiating with various California and federal agencies regarding appropriate remedies for the Site. Montrose was never invited to participate in these negotiations. Because Montrose has no liability for conditions at the Site, Montrose had not independently sought to determine risks posed by and appropriate remedies for the Site before receipt of the Original Order.

In 1984, the Site became the subject of litigation. Levin sued Parr Richmond Terminal Company ("PRTC"), the former owner of the Site, and others for fraud in the sale of the Site. <u>See Levin Metals Corp., et al. v. Parr Richmond Terminal Co., et al.</u>, Case No. 255936 (Contra Costa Sup. Ct.). Also in 1984, litigation over the Site commenced in federal court under the

Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended ("CERCLA"), 42 U.S.C. § 9601 et seq.. See Levin Enterprises, et al. v Parr-Richmond Terminal Co., et al., Case Nos. C84-6273-SC, C84-6324-SC, C85-4776-SC (N.D. Cal.) (the "CERCLA litigation"). The history of the Site has been extensively explored through discovery in both litigations. Although Montrose eventually was brought into both the state and federal court actions, Montrose has obtained summary judgment dismissing all claims against it in the state court litigation and has steadfastly denied its liability on the CERCLA claims against it in federal court. The EPA has not intervened in either action.

The EPA, however, was fully aware of the Site, its problems, and its history long before the Original Order was issued on September 28, 1990 or the Amended Order was issued on October 23, 1990. The EPA investigated the Site in August 1986. EPA Administrative Record ("A.R.") 7. The EPA conducted air sampling at the Site in 1989. A.R. 13. On October 26, 1989, the EPA issued a notice that proposed to place the Site on the National Priorities List ("NPL"). 54 Fed. Reg. 43778, 43783. The EPA's Hazard Ranking System analysis underlying the proposed NPL listing considered purported risks posed by the Site and cited discovery from the CERCLA litigation.

When the Site was added to the NPL on March 14, 1990, negotiations between Levin and the State regarding remedial actions, and concurrent negotiations between the parties to the litigations, broke down pending a determination what role the EPA would play at the Site. The EPA, however, refused to make any decision regarding "lead agency" responsibility for the Site until ordered to do so by Judge Conti, the presiding judge in the CERCLA litigation, on June 4, 1990. The EPA finally announced it would become the lead agency for the Site on July 25, 1990. On September 10, 1990, Levin's counsel informed Montrose that the EPA was still "getting up to speed" on the Site.

The EPA, however, without any notice to Montrose, apparently was deciding how to remediate the Site and which persons to order to do so. The EPA was meeting with Levin's consultants and counsel regarding work to be done at the Site at least as early as September 18, 1990. A.R. 24-26. During this process Montrose was (1) not notified that the EPA considered Montrose a "potentially responsible person" ("PRP") for the Site under CERCLA, and (2) not notified of or invited to any discussion of risks posed by or appropriate remedies for the Site.

Instead, on October 2, 1991, Montrose received its first notice of the EPA's decisions to target Montrose and require certain remedial actions in the Original Order itself, which gave Montrose only 24 hours to agree to "fully comply" with <u>all</u> aspects of the Original Order <u>and commence work at the Site</u>. The Original Order required Montrose to meet the following deadlines:

(1) Within 24 hours, notify EPA of Montrose's intent to "fully comply" with the Original Order, despite the Original Order's failure to specifically designate the work to be performed or even estimate its costs. Original Order at 8, 14-15 (A.R. 27).

(2) Within 24 hours, implement 24-hour security at the Site and "restrict access to the Site to all personnel," despite the fact that Levin owns and continues to operate the Site. Original Order at 8.

(3) Within 24 hours, implement a "Work Plan for Removal of Contaminated Soils, United Heckathorn Site, Richmond, California," prepared by Levin's consultants. Original Order at 8.

(4) By October 4, 1990 (48 hours), begin pre-excavation sampling at the Site and demolish Levin's pier over a certain portion of the Site, despite the fact that Montrose does not own or control the Site and has no right to destroy Levin's pier. Original Order at 9.

(5) By October 10, 1990 (8 days), submit results of pre-excavation sampling to the EPA. Original Order at 9.

(6) By October 22, 1990 (20 days), commence excavation of contaminated soils and sediments at the Site, despite the absence of any prepared plan to prevent the spread of contaminants from these actions or regarding the means to dredge the Lauritzen Canal. Original Order at 9.

On or about October 18, 1990, Montrose received a letter from the EPA which purported to amend the Original Order in various ways (A.R. 47). These purported amendments and <u>other</u> changes were incorporated into the Amended Order received by Montrose on or about October 24, 1990. The Amended Order retained essentially all of the above-mentioned requirements and deadlines of the Original Order, and imposed several additional requirements upon Montrose, including the following:

(a) By October 26 (48 hours), notify EPA of Montrose's intent to "comply with all of the terms of [the] Amended Order which were not present in the previous Order." Amended Order at 10 (A.R. 50).

(b) By October 26 (48 hours), submit a detailed plan "for preventing or minimizing the release of contaminated sediments to the Lauritzen Canal" during excavation. Amended Order at 12.

(c) By October 26 (48 hours), "provide a schedule for engineering design and removal of contaminated sediments . . . below mean low water". Amended Order at 13.

(d) Perform "baseline water quality monitoring" in the Lauritzen Canal and Sante Fe Channel prior to any excavation below mean high tide. Amended Order at 12.

(e) By December 23, 1990 (60 days), begin removal of contaminated sediments below mean low water. Amended Order at 13.

Because of the extremely short deadlines imposed by both the Original Order and the Amended Order, Montrose had no choice but to rely upon, and in fact did rely upon, Levine-Fricke, Levin's consultants, who were familiar with the Site. Also, immediately upon receipt of the Original Order, Montrose filed a request pursuant to the Freedom of Information Act ("FOIA"), as the EPA required, to obtain the documents the EPA was relying upon in issuing the Original Order, including the "administrative record." The EPA did not provide the administrative record in response to the FOIA request, and therefore, when the EPA's administrative record eventually was made available to the public, Montrose engaged an outside copying service to copy the EPA's administrative record and the supplemental material later released by the EPA.

On December 17, 1990, Montrose filed a second FOIA Request to obtain copies of documents held by the EPA regarding the Site. Despite subsequent correspondence and alternative proposals offered by Montrose to secure copies of such documents, Montrose has not received any of the information requested in its December 17, 1990 FOIA request or permission to review the EPA's file regarding the Site.

As set forth more fully herein, Montrose submits that the Amended Order is arbitrary, capricious, and not in accordance with law and the EPA's own regulations for the following reasons: (1) Montrose is not liable under CERCLA for conditions at the Site; (2) the Amended Order seeks to bind other persons not liable under CERCLA; (3) the Amended Order seeks to impose joint and several liability upon the "Respondents" thereto, which is not permitted by CERCLA § 106; (4) the Amended Order fails to include parties liable for conditions at the Site or other parties similarly-situated to Montrose; (5) the Site does not pose an imminent and substantial endangerment to public health or the environment as required for a valid CERCLA § 106(a) administrative order; (6) the EPA's and Amended Order's failure to provide adequate notice of and opportunity to respond to the ordered work violated Montrose's right to due process, CERCLA, and the EPA's regulations; (7) the Amended Order demands that Montrose take actions that are beyond its abilities or would expose Montrose to liability; (8) the Amended Order demands actions be performed which are not feasible; and (9) the Amended Order improperly denies the United States' liability for actions that the EPA has ordered.

Further, as set forth more fully herein, Montrose submits that the "United Heckathorn Superfund Site Removal Administrative Record File" (the "Administrative Record") <u>does not support</u> the Amended Order's conclusions that: (1) Montrose is liable under CERCLA; (2) contaminants at the Site pose any measurable risk to human health; (3) contaminants at the Site pose an imminent and substantial threat to human health or the environment requiring immediate action without further study; (4) the remedies selected for the Site are removal measures rather than remedial measures; and (5) the remedial measures selected by the Amended Order are appropriate for the Site and not inconsistent with the National Contingency Plan ("NCP").

I. <u>The Amended Order Is Arbitrary, Capricious and Contrary to Law and the EPA's Regulations</u>

A. <u>Montrose Is Not Liable Under CERCLA 107(a)</u>

To be subject to an administrative order issued pursuant to CERCLA § 106, Montrose must be a liable party under CERCLA § 107(a). <u>See</u>, <u>e.g.</u>, <u>United States v. Bliss</u>, 667 F. Supp. 1298, 1313 (E.D. Mo. 1987). The Amended Order asserts that "Respondents are 'responsible parties' as defined in Section 107(a) of CERCLA, 42 U.S.C. Section 9607(a)." Amended Order at 8 (A.R. 50). Montrose's alleged liability apparently is based upon the allegation that Montrose "contracted with the Heckathorn

Companies for the grinding of DDT, including Montrose-owned DDT." Amended Order at 3.

CERCLA § 107(a), 42 U.S.C. § 9607(a), imposes liability upon four classes of persons: (1) present owners of the Site; (2) former owners or operators of the Site at a time of disposal; (3) persons who arranged for disposal of waste hazardous substances they own or possess at the Site; and (4) persons who transported waste hazardous substances to the Site for disposal and selected the Site. As the EPA should know from its review of discovery materials in the CERCLA litigation, Montrose does not own the Site, never owned or operated the Site, never arranged for the disposal of any waste hazardous substance it owned or possessed at the Site, and never transported any waste hazardous substance to the Site for disposal. For that reason, Montrose has a valid defense to the Amended Order, and it was arbitrary, capricious, and contrary to law for the EPA to name Montrose as a "Respondent" to the Amended Order.

B. <u>The Amended Order Seeks to Bind Other Persons Not Liable Under CERCLA</u>

As noted above, only persons that are liable under CERCLA § 107(a) may be subjected to a CERCLA § 106 administrative order. The Amended Order states that it applies to and "is binding upon the Respondents, their officers, directors, agents, employees, contractors, successors, and assigns." Amended Order at 18 (A.R. 50). There is no finding in the Amended Order or evidence anywhere that any of the officers, directors, agents, employees, contractors, successors, or assigns of Montrose are responsible parties under CERCLA § 107(a). Therefore, it was arbitrary, capricious, and contrary to law for the EPA to name such persons as bound to comply with the Amended Order.

C. <u>The Amended Order Seeks to Impose Joint and Several Liability Upon "Respondents," Which Is Not Permitted by CERCLA § 106(a)</u>

The Amended Order purports to require "[e]ach Respondent [to] fully implement the plan as approved by EPA within the required time period and shall fully cooperate with each other in carrying out any and all activities required pursuant to this Amended Order." Amended Order at 14-15 (A.R. 50). The Respondents are identified as Chemwest, Levin Richmond Terminal Corporation and Levin Enterprises (collectively, "Levin"), "Parr Richmond Terminal Corporation" [sic] ("PRTC"), "Montrose Chemical Corporation" [sic] ("Montrose"), Shell Oil

Company ("Shell"), and Rhone-Poulenc Basic Chemical Company ("Rhone-Poulenc"). Amended Order at 1-2.

As set forth in United States v. Stringfellow, 20 ERC 1905, 1910 (C.D. Cal. 1984), CERCLA § 106(a) does not encompass "what plaintiffs describe as 'joint and several liability to abate.'" Therefore, even if Montrose were a liable party under CERCLA § 107(a), which it is not, the EPA (1) cannot order Montrose to perform work at the Site that is in excess of Montrose's equitable share of such liability, and (2) must expressly designate the work to be performed by Montrose. Because the Amended Order fails to meet either of these requirements, it is invalid.

D. The Amended Order's Failure to Include As Respondents All Owners and Operators of the Site, and Other Entities Similarly-Situated To Montrose, Is Arbitrary and Capricious

The Amended Order is addressed only to "Respondents" Chemwest, Levin, PRTC, Montrose, Shell and Rhone-Poulenc. The Amended Order, while naming three additional parties not included as Respondents in the Original Order, does not include all of the operators of the Site, the individuals who controlled the former owners of the Site, or other parties similarly-situated to Montrose. In response to a CERCLA § 104(e)(2) information request by the National Oceanic and Atmospheric Administration ("NOAA"), Montrose submitted on March 15, 1990 considerable information about other parties involved with the Site. The EPA has reviewed Montrose's response to NOAA. Levin's counsel has made the pleadings in the CERCLA litigation available to the EPA. The failure to include as "Respondents" former operators and owners of the Site, who are directly responsible for any contamination there, as well as other parties similarly-situated to Montrose, which the EPA wrongly asserts is liable for such contamination, renders the Amended Order arbitrary and capricious.

E. The Amended Order Is Invalid Because There Is No Imminent or Substantial Endangerment Posed By Conditions At the Site

Under CERCLA § 106(a), the EPA may issue an administrative order only where "necessary to protect public health and welfare and the environment" from "an imminent and substantial endangerment . . . because of an actual release or threatened release of a hazardous substance from a facility." 42 U.S.C. § 9606(a). The EPA has recognized that it "must be able to properly document and justify both its assertion that an immediate and significant risk of harm to human life or health or to the environment exists and its choice of the ultimate response action at a site in order to be able to oppose a challenge to the Order." OSWER Directive 9833.1A, "Issuance of Administrative Orders for Immediate Removal Actions" at 3 n.1 (1984).

The presence of DDT, dieldrin and other pesticide residues at the Site does not pose an imminent or substantial endangerment to the public health or welfare or the environment. This issue is discussed in detail below, but the absence of a genuine threat is best evidenced by (1) the EPA's failure to do anything to address such purported threat for at least 4 years despite its knowledge of the Site and (2) the EPA's contractors' conclusions that the Site required little immediate response. The only immediate on-site action recommended in an EPA contractor's 1986 report was the posting of signs and a halt to dredging in the Lauritzen Canal (a point at odds with the Amended Order's requirement to dredge the Canal). See A.R. 7 at 8-1. In both 1988 and 1990, EPA contractors rated the overall risk from the Site as "low." See A.R. 12 at VII-2; A.R. 23 at 1.

The EPA actually admits that removal of sediments at the Site is "non-time critical." Exhibit 1 at 2. The Zelikson January 31, 1991 letter implicitly recognizes the absence of an imminent threat posed by the sediments in their present form and the real threat of harm which may result from dredging those sediments.

Given the absence of any documented imminent and substantial threat to human health or the environment from pesticide residues in the soils of the upland and embankment areas of the Site, and sediments in the Lauritzen Canal, the Amended Order is invalid.

F. The EPA and Amended Order Failed to Provide Adequate Notice of Contemplated Work and Opportunity to Respond.

Montrose received the Original Order on October 2, 1990. The Original Order demanded that Montrose perform the following actions within the following time deadlines:

(1) Within 24 hours, notify EPA of Montrose's intent to "fully comply" with the Original Order, despite the Original Order's failure to specifically designate the work to be performed or even estimate its costs. Original Order at 8, 14-15 (A.R. 27).

(2) Within 24 hours, implement 24-hour security at the Site and "restrict access to the Site to all personnel," despite the fact that Levin owns and continues to operate the Site. Original Order at 8. In response to Montrose's inquiry, the EPA stated that Montrose was required to prevent Levin's employees from entering their workplace on the Site. See Exhibit 2.

(3) Within 24 hours, implement a "Work Plan for Removal of Contaminated Soils, United Heckathorn Site, Richmond, California," prepared by Levin's consultants. Original Order at 8.

(4) By October 4, 1990 (48 hours), begin pre-excavation sampling at the Site and demolish Levin's pier over a certain portion of the Site, despite the fact that Montrose does not own or control the Site and has no right to destroy Levin's pier. Original Order at 9. In response to Montrose's inquiry, the EPA insisted that Montrose was required to ensure that Levin's pier was demolished, but refused to indemnify Montrose for any resulting claims by Levin. See Exhibit 2.

(5) By October 10, 1990 (8 days), submit results of pre-excavation sampling to the EPA. Original Order at 9.

(6) By October 22, 1990 (20 days), commence excavation of contaminated soils and sediments at the Site, despite the absence of any prepared plan to prevent the spread of contaminants from these actions or regarding the means to dredge the Lauritzen Canal. Original Order at 9.

On or about October 18, 1990, Montrose received a letter from the EPA (A.R. 47) which purported to amend the Original Order. These changes were incorporated into the Amended Order received by Montrose on or about October 24, 1990. In addition to the above-mentioned requirements and deadlines of the Original Order, the Amended Order imposed several further requirements upon Montrose, including the following:

(a) By October 26 (48 hours), notify EPA of Montrose's intent to "comply with all of the terms of [the] Amended Order which were not present in the previous Order", despite the Amended Order's failure to specifically designate the additional work to be performed or estimate its costs. Amended Order at 10 (A.R. 50).

(b) By October 26 (48 hours), submit a detailed plan "for preventing or minimizing the release of contaminated sediments to the Lauritzen Canal" during excavation. Amended Order at 12.

(c) By October 26 (48 hours), "provide a schedule for engineering design and removal of contaminated sediments . . . below mean low water". Amended Order at 13.

(d) Perform "baseline water quality monitoring" in the Lauritzen Canal and Sante Fe Channel prior to any excavation below mean high tide. Amended Order at 12.

(e) By December 23, 1990 (60 days), begin removal of contaminated sediments below mean low water. Amended Order at 13.

The Amended Order specifically provides that "[t]he effective date of this Amended Order does not alter the schedule contained in the [Original] Order" as to the original Respondents. Amended Order at 20 (A.R. 50). This requirement is imposed upon the original Respondents despite apparent conflicts between time requirements specified in the Original Order and the Amended Order.[1/]

The Amended Order's demand that Montrose perform the above actions within the specified deadlines was arbitrary, capricious and contrary to law. Under the United States Constitution, Montrose has a due process right to receive adequate notice of, and adequate opportunity to respond to the Amended Order. Under the Amended Order's deadlines, Montrose was not only denied an adequate opportunity to consider whether the

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1. For example, the Original Order requires the Respondents to "commence excavation of contaminated . . . sediments by October 22, 1990." Original Order at 9 (A.R. 27). The Amended Order repeats this requirement and stresses that the original Respondents "were ordered to commence excavation on October 22, 1990 and remain subject to the schedule contained in the previous order", Amended Order at 11 (A.R. 50), despite the Amended Order's additional requirements to provide a schedule by October 26 (48 hours) for engineering design and removal of certain contaminated sediments and to begin removal of such sediments by December 23 (60 days).

proposed remedial activities were appropriate or posed a greater risk to the environment than the existing condition of the Site, but was also denied an opportunity to determine a means by which to comply with the Amended Order and the costs of such actions.

The Original Order's and Amended Order's abrupt issuance also violated CERCLA and the EPA's own regulations. CERCLA § 122(a) directs the EPA to prefer negotiation and settlement with alleged PRPs, and requires the EPA to notify alleged PRPs of any decision not to utilize the negotiation and settlement provisions therein. The National Contingency Plan states that, "[w]here the responsible parties are known, an effort initially shall be made, to the extent practicable, to determine whether they can and will perform the necessary removal action promptly and properly." 40 C.F.R. § 300.415(a)(2).

Similarly, EPA directives provide that, absent an emergency, "PRPs should be notified prior to issuance of a unilateral administrative order." OSWER Directive 92.100.2-02. OSWER Directive 9833.0-1(a) states:

> "Unilateral orders are typically to be issued at the end of the special notice period if settlement is not reached at a site, an extension of negotiations is not warranted, and the case meets statutory criteria and case specific considerations set forth in this guidance."

Id. at 5. OSWER Directive 9360.0-03B specifically provides: "Notification should give the PRPs a reasonable amount of time to respond . . .." OSWER Directive 9833.1A provides that the "[On-Scene Coordinator] or the Regional Counsel will attempt to orally contact (with written follow-up) potentially responsible parties in order to secure private-party response in lieu of the Fund" before the "Regional Administrator decides to issue an Administrative Order." Id.

The EPA's failure to provide Montrose due notice of and adequate opportunity to respond to the actions required by the Amended Order was entirely unnecessary. The EPA was notified of Levine-Fricke's study of the Site's "hot spot" in February 1990, the Site was listed on the NPL in March 1990, the Amended Order adopted Levin-Fricke's May 14, 1990 proposed work plan, the EPA decided to become "lead agency" for the Site in July 1990, and met with Levine-Fricke regarding cleanup activities at least in early September 1990. The EPA's failure to contact any party other than Levin with regard to the Site until issuance of the

Original Order is inexplicable and makes the unreasonable deadlines in the Original Order and Amended Order inexcusable.

The Amended Order is invalid because of the EPA's and the Amended Order's failure to provide adequate time for Montrose to determine whether the ordered actions were environmentally protective, how to comply, and whether Montrose is able to comply.

G. The Amended Order Is Invalid Because It Commands Montrose to Perform Actions Beyond Its Ability and Contrary to Law

The Amended Order commands Montrose to take actions that Montrose has no legal right to undertake and which are beyond Montrose's power:

(1) The Amended Order demands that Montrose implement 24-hour security at the Site. Amended Order at 10 (A.R. 50). When Montrose protested that it did not own or control the Site and therefore could not implement security at the Site, the EPA insisted that Montrose ensure that adequate security measures approved by the EPA were in place at the Site. Although the EPA conceded that Levin had provided information regarding its security measures at the Site, until very recently the EPA refused to state in response to requests by Montrose and others whether those security measures were adequate and acceptable to the EPA. See Exhibits 2, 3. The EPA refused to grant Montrose's request to modify this requirement to place the burden of ensuring security at the Site solely on Levin, which is the only party that owns and controls the Site. See Exhibits 2, 4.

(2) The Amended Order demands that Montrose "restrict access to the Site to all personnel." Amended Order at 10. In response to Montrose's inquiry, the EPA informed Montrose that the "Site" constituted the entire "United Heckathorn Site" and that Montrose had a duty to prevent Levin's employees from entering the "Site" where they work. See Exhibit 2. Montrose requested that the EPA modify this requirement to only require restriction of access to the area of the so-called "hot spot," see Exhibit 2, but the EPA refused to do so. See Exhibit 3. The EPA also refused to grant Montrose's request to modify this requirement to

place the burden of restricting access to the Site solely upon the Site owner, Levin. See Exhibits 2, 4. Montrose has no authority to prevent persons from entering property owned by another person, particularly where such persons are employees of a business located at that property. Montrose does not own or control the Site and cannot restrict access to the Site.

(3) The Amended Order incorporates, and demands that Montrose implement, the Levine-Fricke "Work Plan for Removal of Contaminated Soils" dated May 14, 1990 (the "Work Plan"). Amended Order at 10-11, 13 (A.R. 50). The Amended Order requires the original Respondents to adhere to the schedule established in the Original Order for implementing the Work Plan. Amended Order at 11. Montrose does not own or control the Site and therefore cannot undertake any work at the Site without the consent of Levin Enterprises, the present owner of the Site. Moreover, the Work Plan contemplates dismantling portions of Levin's wharf, Work Plan at 6 & Fig. 4 (attached to Amended Order) (A.R. 50), and the Original Order specifically commands the Respondents to undertake "the demolition of the Levin pier over the area of visible cream-colored residue on the Lauritzen Canal embankment" by October 4, 1990. Original Order at 9 (A.R. 27). When Montrose protested that it did not own or control Levin's pier and therefore had no right to demolish it, the EPA informed Montrose that it was required to ensure that Levin's pier was demolished. See Exhibits 2-3. The EPA, however, refused to indemnify Montrose for any claims by Levin that might result if Montrose were to demolish Levin's pier. Exhibit 2. Montrose has no legal right to enter Levin's property and destroy its pier without Levin's approval; for the EPA to order Montrose to do so not only invites violence, it renders the Amended Order arbitrary and capricious.

(4) The Amended Order demands that Montrose "provide EPA employees and other representatives with complete access to the facility at all times." Amended Order at 16 (A.R. 50). Montrose does not own or control the Site and therefore cannot provide access to the Site. Montrose requested the EPA to modify this requirement to impose the burden of ensuring access solely on the Site owner, Levin. See Exhibit 2. The EPA refused to do so. See Exhibit 3.

(5) Montrose has limited financial resources and its claims of indemnity for liability, if any, stemming from the Site are being contested by its insurers in pending litigation. The Amended Order provides no estimates of the costs of performing the work required by the Amended Order (perhaps because the work is not sufficiently specified to permit estimation). Under such circumstances, it is unreasonable for the Amended Order to insist that Montrose notify EPA within 48 hours of its intent to comply with all terms not present in the Original Order because Montrose could not and cannot determine whether it is financially able to perform all of the work required by the Amended Order's additional terms.

H. <u>The Amended Order Unreasonably Insists That, Despite Its Deadlines, Montrose Comply With All Other Federal, State and Local Laws</u>

The Amended Order demands that Montrose "comply with all federal, state and local laws and regulations in carrying out the terms of this Amended Order." Amended Order at 15 (A.R. 50). The Amended Order also demands, however, that the original Respondents implement the "Work Plan for Removal of Contaminated Soils, United Heckathorn Site, Richmond, California" in accordance with the schedule established in the Original Order. Amended Order at 11. The Original Order required Montrose to implement the Work Plan within 24 hours of Montrose's receipt of the Original Order. Original Order at 8 (A.R. 27). It is impossible to ascertain, much less obtain, the required federal, state and local approvals that may be required to carry out the terms of the Amended Order in compliance with all federal, state, and local laws, particularly where dredging of the Lauritzen Canal is required, within the permitted time periods.

I. <u>The Amended Order Improperly Disclaims Liability For the Actions It Requires</u>

The Amended Order asserts that the "United States Government and its employees and other representatives shall not be liable for any injuries or damages to persons or property resulting from the acts or omissions of Respondents, their employees or other representatives caused by carrying out this Amended Order." Amended Order at 17 (A.R. 50). It is arbitrary and capricious for the EPA to order Montrose to comply with all aspects of the Amended Order, upon threat of $25,000 per day fines and treble damages, and then deny responsibility for any injuries that may result from performance of the acts prescribed in the Amended Order, particularly the unstudied effects of dredging the Lauritzen Canal.

J. <u>The Amended Order Improperly Fails to Specifically Define the Response Actions Required</u>

The Amended Order is impermissibly vague in defining the work required to comply with the Amended Order. OSWER Directive No. 9833.0-1A states:

> Unilateral orders should specifically define the response action required, to the maximum extent possible. A specifically identified response action is required for implementation by the PRPs, for the agency to determine compliance, and for the order to be legally enforceable. . . . Often the order should also include a statement of work.

<u>Id</u>. at 15. Here, the Amended Order requires the excavation and dredging of an undetermined lateral area of contaminated soil and sediments, excavation and dredging of an undetermined vertical area of contaminated soil and sediments, "removal" of contaminated sediments without any definition of the means by which such removal is to be conducted, commencement of dredging in a time not permitting development of the most environmentally-protective plan to accomplish dredging, and treatment and disposal of dredged sediments whose chemical and metal contaminants have not been fully characterized. The Amended Order's failure to specifically define the work to be performed renders it invalid.

II. <u>The Administrative Record Does Not Support the Amended Order's Conclusions</u>

A. <u>The Administrative Record Does Not Support the Amended Order's Conclusion that Montrose Is Liable Under CERCLA</u>

As set forth above, Montrose must be a liable party under CERCLA § 107(a) to be subject to a CERCLA § 106(a) administrative order. CERCLA § 107(a) imposes liability upon four classes of persons: (1) present owners of the Site; (2) former owners or operators of the Site at a time of disposal; (3) persons who arrange for disposal of waste hazardous substances they own or possess at the Site; and (4) persons who transport waste hazardous substances to the Site for disposal and select the Site. 42 U.S.C. § 9607(a)(1)-(4).

There is no evidence whatsoever in the Administrative Record that suggests that Montrose owns the Site, owned or operated the Site at a time of disposal, arranged for disposal of waste hazardous substances owned or possessed by Montrose at the Site, or transported waste hazardous substances to the Site for disposal. Given the absence of any such evidence in the Administrative Record, it was arbitrary and capricious for the EPA to name Montrose a "Respondent" to the Amended Order.[2]

B. <u>The Administrative Record Does Not Support the Conclusion that the Site Poses an Imminent and Substantial Endangerment to Public Health or the Environment</u>

1. <u>CERCLA and EPA Regulations Require a Threat of Imminent and Substantial Endangerment for Issuance of an Unilateral Administrative Order</u>.

CERCLA § 104, 42 U.S.C. § 9604, provides authority for the President to act, consistent with the National Contingency Plan ("NCP"), to protect public health or the environment by removing or arranging for the removal of, and providing for remedial action relating to, hazardous substances where there is a release or a substantial threat of a release of such hazardous substances into the environment. The President may undertake such action <u>without</u> a finding that the release or threatened release poses an "imminent and substantial endangerment to human health or welfare or the environment."

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2. Perhaps recognizing the Administrative Record's lack of evidence demonstrating Montrose's purported liability for the Site under CERCLA, the EPA, on November 27, 1990, almost a month after naming Montrose a "Respondent" to the Original Order, sent Montrose a "Request for Information" pursuant to CERCLA § 104(e)(2) that stated its purpose was "to request information regarding [Montrose's] association with the Site." <u>See</u> Exhibit 5. The information request also states that the "EPA is conducting this investigation to determine the nature and extent of contamination in the area, to assess the effects of contamination on the environment and public health, and to identify activities and parties that contributed to contamination in the area." <u>Id</u>. If the EPA did not understand the nature and extent of contamination at the Site or the effects of such contamination on the environment and public health, it should not have issued the Original Order or Amended Order.

In sharp contrast, CERCLA Section 106(a) provides:

> "[W]hen the President determines that there may be an imminent and substantial endangerment to the public health or welfare or the environment because of an actual or threatened release of a hazardous substance from a facility, he . . . may also, after notice to the affected state, . . . issu[e] such orders as may be necessary to protect public health and welfare and the environment."

42 U.S.C. § 9606(a) (emphasis added).[3]

Issuance of an unilateral administrative order under CERCLA § 106(a) is permitted only where there is an imminent or substantial endangerment because such orders impose a harsh choice on recipients. Failure to comply with a CERCLA § 106(a) order without sufficient cause may subject the recipient to civil penalties up to $25,000 per day and punitive damages of up to three times the total cost incurred by the United States to perform work required by the order. 42 U.S.C. § 9606(b); id. § 9607(c)(3). Moreover, the United States insists that the recipient cannot obtain any pre-enforcement review of the order's validity. Consequently, CERCLA requires and the EPA should carefully ensure that a Section 106 order is issued only when it truly appears that there may be an (1) imminent and (2) substantial endangerment in accordance with CERCLA's plain language.

The EPA states that the risk or likelihood of an imminent and substantial endangerment to public health or welfare or the environment must be judged by examining the factual circumstances, including, but not limited to: (1) the nature and amount of the hazardous substance involved; (2) the potential for exposure of humans or the environment to the substance, and (3) the known or suspected effect of the substance on humans or that part of the environment subject to exposure to the substance. OSWER Directive No. 9833.0 at 5.

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3. There is no evidence in the Administrative Record that the EPA notified the State of California before issuing the Original Order or Amended Order. Based upon the Administrative Record, the EPA's issuance of the Original Order and Amended Order was contrary to the plain language of CERCLA § 106(a).

Contrary to the Amended Order's conclusions, a review of the Administrative Record and other evidence demonstrates that the Site poses no imminent and substantial endangerment to the public health or welfare or the environment. Given that the Amended Order requires removal of both contaminated soils and sediments, the Administrative Record must establish that both the soils and sediment pose an imminent and substantial endangerment to justify the Amended Order. It does not do so.

2. The Site Poses No Threat to Human Health.

Any determination of endangerment from DDT at the Site must identify both the "dose" to which people are exposed, i.e. how much DDT will be available to be ingested or absorbed by a person, the "response" to that "dose," i.e. whether the amount of DDT to which the person is exposed will adversely affect that person, and a "pathway" by which a person in fact will be exposed to a harmful "dose." The Administrative Record contains virtually no evidence regarding "dose," "response," or "pathyways," and no evidence supporting a finding of imminent and substantial endangerment to human health.

The EPA's own contractor investigating the Site recognized there was and is little risk to human health posed by the Site. In 1986, the only immediate on-site action recommended by the EPA's contractor was the posting of signs to "warn the public of potential dangers due to the DDT and heavy metal contamination," which should remain posted until the "threat is well understood," and to halt dredging in the Canal. A.R. 7 at 8-1. The EPA's contractor saw no need for immediate removal of DDT-contaminated soils or sediments.

A "Hazardous and Toxic Material Team Site Safety Plan" submitted on behalf of the EPA by Ecology and Environment, Inc., dated December 14, 1987, revised June 30, 1988, assigns the lowest available category to the Site for "Overall Hazard". See A.R. 12 at VII-2. Likewise, a "Site Safety Plan" submitted by the same contractor, dated September 12, 1990, again assigns the lowest available category to the site for "Overall Chemical Hazard" and "Overall Physical Hazard." See A.R. 23 at 1. These reports demonstrate that the EPA's own contractors consider the risk to human health at the Site to be minimal.

In considering the likely "response" to any DDT exposure, the EPA failed to consider that independent studies consistently have found that DDT exposure poses little, if any, risk to human health. Although the EPA included selected portions of the EPA publication "Ambient Water Quality Criteria for DDT" as part of the administrative record, see A.R. 2, the EPA elected not to include certain pages which explain that "[n]o clinical or laboratory evidence of injury to man by repeated exposure to DDT has been reported." Exhibit 6 at C-32. As explained in the comments on the Administrative Record submitted by Dr. Virgil Freed, Professor Emeritus of Agricultural Chemistry at Oregon State University ("Freed Comments"), independent studies of workers exposed to DDT and other epidemiologic studies have found no association between human DDT exposure and adverse health effects. Freed Comments at 3; accord A.R. 32 at 3. DDT is non-genotoxic, has a negligible immunitoxic effect, and poses at most a very small cancer risk. Freed Comments at 6. In fact, extensive epidemiologic studies have failed to show that DDT has any carcinogenic effect in humans. Freed Comments at 9; A.R. 2 at C-93; A.R. 32 at 3.

The EPA's own Administrative Record demonstrates that DDT, even in large amounts, presents a relatively low hazard to warm-blooded animals (including humans). See, e.g., A.R. 23 at 16. In a letter regarding the health risks to Levin workers at the Site, Dr. Stuart Anderson Peoples, Professor Emeritus at the University of California, Davis, explained that the 1972 federal DDT ban was not due to acute or human toxicity to the chemical substance. A.R. 3 at 1. Dr. Peoples states that during World War II, "citizens of Africa and Italy were literally dusted with [DDT] to control typhus endemic there," yet "there were no acute cases of poisoning from these massive applications." Id. Dr. Peoples concludes in his letter that there is no possibility of acute poisoning to workers at the Site, even in areas of heavy contamination. Id.

The Administrative Record also states that human volunteers have ingested up to 35 mg of DDT per kilogram of body weight daily for 21 months with no apparent ill effects. A.R. 32 at 6; accord Exhibit 6 at C-32 to 33. The same chemical analysis also indicates that almost no irritation occurs from direct skin contact to DDT, and solid DDT cannot be absorbed through the skin. A.R. 32 at 5. A portion of the EPA publication "Ambient Water Quality Criteria for DDT" not included in A.R. 2 states that "the dermal toxicity of DDT in humans is practically nil." Exhibit 6 at C-33. Studies by the World Health Organization and others also demonstrate that DDT is poorly absorbed through the skin. Freed Comments at 6. Respiratory absorption rates for DDT are also low. Id.

Even assuming, contrary to the weight of evidence, that DDT poses a threat to human health to which people may be exposed by conditions at the Site, the EPA's own Administrative Record demonstrates that the Site provides no "dose" to which humans may be exposed. Turning first to the air pathway, a document entitled "Pesticide Air Sampling and Analysis Plan," prepared by Ecology and Environment, Inc. for the EPA and dated June 13, 1988, reports that, as an interim remedial measure, Levin placed 6-8 inches of gravel throughout the site in 1983 and also covered contaminated soil piles with a synthetic membrane. A.R. 12 at II-5, VII-2. The Administrative Record is replete with references of this prior remedial action, which prevents direct exposure to contaminated soils and minimizes airborne release of contaminants. E.g., A.R. 7 at 2-8, 2-11, 4-1, 5-1; A.R. 13 at 2-4; A.R. 17 at 2; A.R. 35 at 10. Dr. Freed has explained that DDT's chemical properties, including low vapor pressure and strong sorption to soil, indicate that DDT poses "little risk as an airborne source." Freed Comments at 9.

Data reported to the EPA and included in the Administrative Record prove that no risk to human health exists from air pathways. The June 13, 1988 Pesticide Sampling and Analysis Plan prepared by the EPA's contractor indicates that air sampling previously taken at the Site revealed that DDT air contamination was "at least 1,000 times below the CAL-OSHA PEL." A.R. 12 at VII-2. Subsequent air sampling results produced by Ecology and Environment, Inc. on behalf of the EPA confirm that air contamination at the Site is far below actionable levels.

A report dated February 15, 1989 states that the highest detected level of airborne DDT at the site was 310 ng/m^3. A.R. 13 at 7-1. The OSHA Permissible Exposure Limit ("PEL") for DDT is 1 mg/m^3. 29 C.F.R. § 1910.1000; A.R. 14 at 24, Table 1; A.R. 23 at 2, 15. Thus, the PEL for DDT is more than 3,000 times greater than the highest airborne DDT level detected at the Site. The action level for fugitive DDT dust at the United Heckathorn site, calculated as 5.7 mg/m^3 by Levine-Fricke in a November 6, 1989 Health and Safety Plan, A.R. 14 at 24, is more than 18,000 times greater than the highest level detected at the Site. Thus, evidence in the Administrative Record proves "very low airborne DDT concentrations" exist at the site. A.R. 18 at 3, 61.

The supplemental material to the Administrative Record further demonstrates that any air contamination existing at the Site is far below permissible levels. A.R. 35 at 51, 79; A.R. 36, App. D, EAL Corporation Environmental Air Monitoring Survey at the United Heckathorn Site, June 16, 1983 ("1983 Air Monitoring Survey") at 1, 3. A Site Characterization and Remedial Action Plan Report written in 1986 directly states that "the ambient air presents a very low risk to on-site and off-site human receptors." A.R. 35 at 87.

The likelihood of direct contact with DDT at the Site, which theoretically could permit ingestion or dermal absorption of DDT, is extremely unlikely. The Administrative Record contains references to additional protective measures already employed at the site that prevent direct human exposure to DDT. The entire site is fenced and posted, and security personnel are present on a 24-hour basis. A.R. 18 at 61. The area of the former Heckathorn facility is cordoned off. A.R. at 2-8. There are no boat ramps or other public shoreline facilities on the Lauritzen Canal, and the heavily industrialized use of this area greatly discourages public access. A.R. 18 at 61. The Administrative Record contains no evidence that the Lauritzen Canal is used for aquatic recreation.

The supplemental material to the Administrative Record expressly states that, due to the protective equipment plan already developed for workers at the Site, the risk posed by contaminated upland soils for exposure to humans through dermal contact or inhalation is "very low." A.R. 35 at 82. Likewise, the risk posed by contaminated embankment soils for exposure to humans through dermal contact or inhalation is "very low," A.R. 35 at 83, and the risk posed by contaminated canal sediments for exposure to humans through ingestion is "very low." A.R. 35 at 84.

Turning to the groundwater pathway, the Administrative Record again confirms no risk exists. The EPA's contractor acknowledges that groundwater within at least a 3-mile radius of the Site is <u>not used</u> for drinking or irrigation. <u>See</u> A.R. 13 at 5-1; <u>accord</u> A.R. 7 at 3-1 to 3-2; A.R. 18 at 62. Likewise, surface water around the Site is not used for drinking. A.R. 13 at 5-1. The supplemental material to the Administrative Record explains that "since the site ground water will not be used for domestic consumption, the risk to human health is considered very low." A.R. 35 at 86. In fact, the short-term and long-term human health and environmental risks posed by groundwater at the Site is considered so low that "no action" is recommended for remediating the groundwater. A.R. 35 at 127, 133.

The EPA states in the Amended Order that there is a threat to public health and welfare from the bioaccumulation of carcinogenic pesticides in aquatic organisms in the San Francisco

Bay which are consumed by humans.[4] Amended Order at 5-6. (A.R. 50). However, "no fishing" warning signs already posted throughout the vicinity of the Site, the current use of the Lauritzen Canal as a shipping channel and the absence of public access routes along the Lauritzen Canal make it unlikely that fish contaminated with DDT will be caught in the Lauritzen Canal for human consumption. See A.R. 18 at 64. There is no evidence in the record that fish contaminated with DDT in excess of the Food and Drug Administration's action level of 5 ppm in fillets have been caught in the Lauritzen Canal.[5] The Administrative Record lacks any evidence that the single fish whose total DDT measurement exceeded 5 ppm ingested the DDT in the Lauritzen Canal or that fish in general ingest DDT in the Canal and then migrate to the San Francisco Bay.[6] Moreover, given that DDT is lipophilic, tends to concentrate in fish livers, and is removed from cooked fish with the fat, there is no evidence in the record that persons are eating uncooked fish livers from fish caught in the Lauritzen Canal.

The supplemental material to the Administrative Record contains extensive evidence disputing any alleged risk to humans from bioaccumulation of pesticides in aquatic organisms. To begin with, in studies of organisms in the Lauritzen Canal, "total DDT levels of benthic species that might be consumed by

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4. The Amended Order's assertion that DDT is a "carcinogenic pesticide" contradicts the EPA's own classification of DDT as a "Class B2 compound, probable human carcinogen" (a chemical for which sufficient evidence exists of carcinogenicity in animals, but for which inadequate or lack of evidence exists of carcinogenicity in humans). See EPA, Health Effects Assessment Summary Tables, OERR 9200.6-303-(89-4).

5. Moreover, all collected data concerning pesticide contamination in seafood taken from the Santa Fe Channel, which is immediately adjacent to the Lauritzen Canal, indicates "DDT concentrations which are well below the FDA action level." AR 18 at 68, 69.

6. The Amended Order states that a single fish and mussels taken directly from the Lauritzen Canal have exceeded Food and Drug Administration ("FDA") action levels. Amended Order at 7 (A.R. 50). The measurement of DDT in the fish, however, was total DDT in the entire fish, whereas the FDA action level applies to fish fillets only. Fish generally store DDT in lipid fat, which is not eaten by humans.

humans were found to be less than the FDA action level, and the data suggest that bioconcentration is not occurring in these species." A.R. 35 at 62. Additionally, studies have indicated that DDT from Lauritzen Canal sediments was not bioconcentrating in clams, which are "the dominant biomass found in the Lauritzen Canal and an excellent indicator of bioconcentration of contaminants." A.R. 36, App. E at 9-10, 12.

The supplemental material, when evaluated closely, also discounts the significance of contamination levels found in some mussels in the Lauritzen Canal. A September 1986 report by Aqua Terra Technologies entitled "Biological Investigation of Lauritzen Canal Baseline Mussel Tissue Analysis" ("Mussel Tissue Analysis") explains that mussel samples from four separate locations in and around the Lauritzen Canal were studied. A.R. 36, App. E, Mussel Tissue Analysis at 1-2. Except for samples taken from the single testing station located directly at the mouth of the storm drain at the northern-most end of the Canal, all mussel tissue levels were "significantly less" than the FDA action levels. Id. at 3. The storm drain location had the most shallow water depth in the entire canal and the greatest amount of sediment resuspension due to the turbulence caused by the storm drain effluent. Id. The DDT level in mussel tissue collected at this highly unrepresentative location was found to be 1.7 times the FDA action level; however, the subject mussels were not depurated prior to tissue analysis as required under proper FDA procedures. A.R. 36 at 61. Moreover, the storm drain has not been eliminated as a possible source of the DDT found in the mussels.

The mussel testing station that should have represented the "worst case" situation in the Canal was located immediately opposite the area with the highest levels of embankment soil and groundwater contamination. DDT tissue levels at this station, however, were six times less than the FDA action levels. A.R. 36, App. E, Mussel Tissue Analysis at 3. Another report in the supplemental material recognizes that levels of pesticide contamination in mussels drops off dramatically moving from the storm drain to the south end of the Canal. A.R. 35 at 61, 62. This report expressly concludes that because there is no public access to the Lauritzen Canal and the area has been posted for no fishing or shellfish collection, the risk to human health posed by the presence of any contaminated mussels in the Canal "is considered very low", A.R. 35 at 84, and that in general "it is doubtful that the DDT contained in the sediments represents a substantial risk of bioconcentration to animals that may migrate into or out of the canal." Id. at 59-60.

The evidence in the Administrative Record, especially in the supplemental material, demonstrates that the potential risk of human exposure to pesticides bioaccumulated in aquatic organisms near the Site is minimal at most. Moreover, as previously described, a chemical analysis submitted to the EPA and included in the Administrative Record indicates that human volunteers have ingested up to 35 mg/kg of DDT daily for 21 months with no apparent ill effects, A.R. 32 at 6, and extensive epidemiologic studies have failed to show that DDT has any carcinogenic effect in humans. Freed Comments at 6, 9. Consequently, the alleged possibility of human exposure from surface water pathways due to the consumption of fish caught in or outside the Lauritzen Canal that may feed upon DDT-contaminated aquatic organisms in the Lauritzen Canal can hardly be considered an "imminent and substantial endangerment" to public health.[7]

The Amended Order asserts that there is an imminent and substantial threat to public health and welfare from direct contact with concentrated DDT at the Site, and refers to a worker at the Site that in 1983 reported various health problems, including vomiting and vision changes, after laying piles and clearing sediments at the Levin pier. Amended Order at 5 (A.R. 50). The Administrative Record contains no medical verification that the health problems reported by this single worker were in fact caused by exposure to DDT. In fact, it is unlikely that such problems could have been caused by exposure to DDT at the Site in light of the previously discussed results of studies on workers exposed to DDT, the study on volunteers who ingested 35 mg/kg of DDT for 21 months, and Dr. Peoples' medical opinion in May 1983 that there was no possibility of acute poisoning to workers at the Site. The supplemental material to the Administrative Record further supports this conclusion, stating that blood samples collected from workers at the Site in 1983 proved "that none of the personnel tested had blood serum DDT levels greater than those expected to occur in the general population." A.R. 35 at 52.

In any event, the Amended Order's allegation that "the current Site condition poses the threat of further direct contact

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7. The absence of an "imminent and substantial endangerment" to public health from bioaccumulation in aquatic organisms is confirmed in supplemental material to the Administrative Record which categorizes the human health risk posed by the Lauritzen Canal sediments, considering all potential methods of exposure, as "very low". A.R. 35 at 4.

with the concentrated DDT" completely ignores the extensive evidence in the Administrative Record demonstrating that, since 1983, substantial measures have been taken to prevent direct exposure to workers or any other persons at the Site. As previously explained, such measures include the placement of 6-8 inches of gravel throughout the site, additional coverage of contaminated soil piles with a synthetic membrane, and the establishment of fencing and posted warning signs around contaminated areas. A.R. 7 at 2-8, 2-11, 4-1, 5-1; A.R. 12 at II-5, VII-2; A.R. 13 at 2-4; A.R. 17 at 2; A.R. 18 at 61; A.R. 35 at 10. The Administrative Record contains no evidence of any human health complaints attributed to DDT since 1983.

The Administrative Record does not contain a single medically verified report of adverse health effects due to exposure to contaminants at the Site. Even if it were assumed that the 1983 reported health complaint was due to contaminants at the Site, this single complaint originating over seven years ago simply does not justify a conclusion that an imminent and substantial endangerment to public health exists at the Site. The fact that not a single reported health complaint concerning exposure to contaminants at the Site has been reported, much less verified, for over seven years actually <u>confirms</u> that the Site conditions do not pose an imminent and substantial threat to human health.

Finally, the EPA's assertion that the Site represents an imminent and substantial endangerment to human health directly contradicts supplemental material to the Administrative Record which states that: <u>no action</u> to the upland soils poses "no short-term human health risks" and "very low" long-term human health risks, A.R. 35 at 90; <u>no action</u> to embankment soils poses "very low" short-term and long-term human health risks, A.R. 35 at 101-02; <u>no action</u> to canal sediments poses "no short- or long-term human health risks", A.R. 35 at 113; and <u>no action</u> to the groundwater poses "very low" short-term and long-term human health risks, A.R. 35 at 127.

3. <u>The Administrative Record Does Not Support the Amended Order's Conclusion that the Site Poses a Substantial Risk to the Environment</u>

The Amended Order requires removal of contaminated soils and sediments with DDT concentrations equal to or above 100 ppm from the area contiguous with the cream-colored residue on the Lauritzen Canal embankment. Amended Order at 11. To justify the demand that both contaminated soils and contaminated sediments be removed, the Administrative Record must support the conclusion that both the contaminated soils and the contaminated sediments pose an "imminent and substantial endangerment" to the environment. The following will address each purported source of contamination in turn.

As discussed above, the DDT in the contaminated soil poses no risk of air release, groundwater release, or direct contact. See supra at II.B.2. Thus, the "dose" to which any land mammals or birds are likely to be exposed is minimal to non-existent. Moreover, to support the Amended Order's conclusion of a risk to wildlife, the Administrative Record must demonstrate that wildlife is likely to be exposed to the contaminated soils. There is no evidence in the Administrative Record, however, that suggests that a wildlife population exists on the Site. Dr. Freed has commented that he did not observe any wildlife, either mammals or birds, on the land area of the Site during his visit there. Freed Comments at 7. Moreover, given that Levin operates a scrap metal and bulk loading operation on the Site, a wildlife population would not be expected.

The supplemental material to the Administrative Record also discounts any alleged risk to aquatic organisms near the Site that could result from contamination of the Site's upland soils, embankment soils or groundwater. For example, studies have demonstrated that DDT at the Site "is tightly sorbed to the silt- and clay-size soils and is highly immobile in the absence of carrier solvents." A.R. 35 at 2. Tests taken at the Site demonstrate that DDT is not leached from contaminated embankment soils to the Lauritzen Canal. A.R. 35 at 83. The groundwater at the Site does not support aquatic life, and seepage of groundwater to the Lauritzen Canal is estimated to be diluted by a factor of at least 70,000 times. A.R. 35 at 33; see also A.R. 35 at 79 ("the pesticide loading rate to the canal is 0.00043 gallon per year or 0.24 ounce per year"). The risk to the environment of continued low-level degradation of the ground water due to contaminated upland soils is also considered "very low" because of the low pesticide concentration in the groundwater and the minimal rate of seepage to the canal. A.R. 35 at 82. Thus, "the risk to the environment posed by ground water is considered very low." A.R. 35 at 86.

Turning to DDT contamination in the Lauritzen Canal sediments as a potential risk to the environment, Montrose notes that the water quality samples taken by Levine-Fricke in November 1990 found no detectable levels of either dissolved or suspended DDT in the Lauritzen Canal water column. These results are not surprising because the low solubility/high adsorption characteristics of DDT suggest that, once in the Lauritzen Canal, any DDT would remain adsorbed onto particulate matter which would settle out of the water column to the sediments. See A.R. 18 at 43, 52. This conclusion is supported by studies conducted by the US Army Corps of Engineers Waterways Experiment Station, which have demonstrated that all chlorinated hydrocarbons are strongly bound to the solid phase in typical soil and sediment-water systems. See Exhibit 7 (M.J. Cullinane et al., W.E. Pequegnat, Contaminated Dredged Material - Control, Treatment and Disposal (1990) (selected pages)) at 702. In fact, field studies designed to determine the potential for long-term release of chlorinated pesticides at subaqueous disposal sites found no such release. Exhibit 7 at 702.

The absence of dissolved or suspended DDT in the Lauritzen Canal water column during the November 1990 testing by Levine-Fricke indicates that the Lauritzen Canal sediments do not release detectable quantities of DDT, at least absent some outside stimulus. This is confirmed by the comments on the Administrative Record submitted by Parametrix, Inc. ("Parametrix Comments"), which demonstrate that the expected release of dissolved DDT from DDT contaminated subtidal sediments would not be detectable and would be expected to be below any level believed to harm aquatic life.

Certain evidence in the Administrative Record suggests that, at least during the 1985-86 period, measurable DDT concentrations were discovered in mussels placed in the Lauritzen Canal by the State of California. See A.R. 6. This result, however, does not support the EPA's conclusion that there presently exists a threat of imminent and substantial endangerment to the environment from DDT concentrations in the Lauritzen Canal sediments. As previously explained, in the Mussel Tissue Analysis conducted by Aqua Terra Technologies in February 1986, the only significant contamination level in mussels was found directly at the mouth of the storm drain at the northern-most end of the canal where the water is the most shallow in the entire canal and where the storm drain effluent causes unique turbulence of sediments and may be an independent source of DDT. A.R. 36, App. E, Mussel Tissue Analysis at 3. Also, in regard to the 1985-1986 Mussel Watch program results, the State of California itself noted that the "DDT-laden sediment within the Canal could have been disturbed by the shipping and dredging activities that occur regularly within the Canal." A.R. 6 at 45. In August 1986, however, the EPA contractor recommended halting "all dredging in the Lauritzen Canal . . . until accurate conclusions can be made on the effect of the contamination on . . . the environment." A.R. 7 at 8-1. Levin has not dredged the Canal since 1984. If boat traffic poses a potential risk of resuspending contaminated sediments, the EPA could limit boat traffic or speeds in the Canal until a more permanent remedial alternative is selected.

The Administrative Record contains no evidence that the Lauritzen Canal sediments are a source of DDT contamination rather than a recipient from some outside source. Unless the sedimentation rate in the Canal is known it cannot be determined whether DDT in the sediments tested was placed there recently or before 1965. Levin's consultant suggested that, "[b]ased on an evaluation of site-specific environmental factors and the chemical properties of the chlorinated pesticides, the most significant contaminant transport pathway is believed to be surface water erosion of chemically affected embankment sediments to the Lauritzen Canal." A.R. 18 at 3, 54. Although the low mobility of DDT in soil casts some doubt on this conclusion, any environmental risk posed by the danger of such erosion could be eliminated simply and with limited collateral environmental risks by further containment of the embankment sediments. Given that such embankment sediments were remediated in November 1990, and given the possibility that contaminated embankment sediments were the sole source of DDT into the Lauritzen Canal water column, further testing should be performed to determine whether there remains any source of DDT into the Lauritzen Canal water column. In fact, the 1987 DHS "Evaluation Report" contained in the supplemental material to the Administrative Record, which critically evaluates deficiencies in prior reports concerning the Site, specifically recommends that "before proceeding with further action at the site" studies need to be performed to "[i]dentify past and existing sources of contamination (e.g., storm drains, effluent discharges and embankment erosion)." A.R. 37 at 7-1.

The EPA also suggests that DDT contamination in the sediments may pose a risk of adverse environmental impact upon benthic organisms that ingest the sediments and, in turn, aquatic organisms, including fish, that ingest benthic organisms contaminated with DDT. The Administrative Record contains little data regarding the species of benthic organisms inhabiting the Lauritzen Canal, whether the benthic inhabitants of the Lauritzen Canal are suffering environmental harm, and whether fish are feeding upon DDT-contaminated benthic organisms in the Lauritzen Canal. The supplemental material to the Administrative Record does, however, state that studies have demonstrated that the Lauritzen Canal sediment "is not chronically toxic to a variety of bay organisms, including the mussel and Dungeness crab." A.R. 35 at 55. The Administrative Record contains no evidence that fish have become contaminated, much less suffered adverse effects, from ingesting DDT contaminated benthic organisms from the Lauritzen Canal.[8] The Administrative Record also contains no evidence that birds, including the California Brown Pelican, have been observed at the Site, which is heavily industrialized. Montrose suggests that a visual observation of the Lauritzen Canal reveals that it is unlikely to be a habitat for birds or marine mammals.

Finally, Montrose notes that, if the EPA is basing the Amended Order upon an imminent and substantial endangerment to the existing benthic community in the Lauritzen Canal, the Amended Order commands their destruction through dredging of the sediments. The supplemental material to the Administrative Record specifically notes that presently there is "a greater abundance and diversity of animals in the northern canal sediments, <u>probably because this section has not been dredged</u>", A.R. 35 at 84 (emphasis added); and that "recolonization of organisms in dredged channels is a slow process when bay mud is the dominant substrate." A.R. 36, App. E, Aqua Terra Technologies "Biological Investigation, Lauritzen Canal" at 4. Given that the benthic organisms, if presently at risk, will be destroyed by the Amended Order's required remedial alternative, the Amended Order is (1) not justified as a removal action, which must be taken to protect the "endangered" population and (2) is invalid because it fails to protect the very environment alleged to be the basis for the Amended Order.

Finally, the EPA's assertion that the Site represents an imminent and substantial endangerment to the environment directly contradicts supplemental material to the Administrative Record which states that: <u>no action</u> to the upland soils poses "no

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8. The Amended Order notes that one fish taken from the Lauritzen Canal was found to contain 13.6 ppm DDT, which exceeds the FDA action level of 5 ppm. Amended Order at 6 (A.R. 50). The Administrative Record contains no evidence that this fish ingested DDT from benthic organisms in the Lauritzen Canal as opposed to elsewhere, or that this fish was in any way affected by the DDT in its body. Moreover, the Amended Order fails to note that the FDA action level of 5 ppm relates to human health only and applies to fillets only, and the 13.6 ppm DDT found in the single fish was a whole body measurement. Fish tend to accumulate DDT in their lipid fat, which humans do not eat. Moreover, the single fish noted was the only one out of 17 samples taken in that study that exceeded the FDA action level even based upon a whole body measurement. <u>See</u> A.R. 10 at 8, Ex. C.

short-term environmental risks" and a "very low" long-term environmental risks, A.R. 35 at 90; no action to embankment soils poses "no short-term environmental risks" and "low" long-term environmental risks, A.R. 35 at 102; no action to canal sediments poses "no short-term environmental risks" and "uncertain" long-term environmental risks, A.R. 35 at 113; and no action to the groundwater poses "very low" short-term and long-term environmental risks, A.R. 35 at 127.

C. The Administrative Record Does Not Justify Immediate Removal Action Without Formal Environmental Review, Consideration of Alternatives, And An Opportunity for Public Comment

To justify issuance of the Amended Order, without any formal review of remedial alternatives and consideration of their own environmental risks, and without any pre-implementation opportunity for public comment, the Administrative Record must establish that the ordered action needed to be taken at the Site within six months. The above consideration of endangerment plainly indicates that a six month delay would not cause any substantial harm, indeed, no discernable harm. In fact, the EPA has since expressly admitted that remediation of contaminated sediments at the Site is "non-time critical" and "a planning period of at least six months [will] be required to resolve all the issues, concerns and technical aspects of dredging sediments from [the] Lauritzen Canal . . .." Exhibit 1 at 2.

It is vital that the lead agency properly determine whether "remedial" versus "removal" action should be employed at a site. This classification determines the nature and extent of environmental evaluations of remedial alternatives that will be required or performed by the lead agency, and whether the public will have an opportunity to comment on the selection of an appropriate remedy. CERCLA § 113(k)(2)(B) regarding remedial actions specifically requires that the EPA employ certain procedures designed to ensure a substantial opportunity for participation by interested persons in the development of "the administrative record on which the President will base the selection of remedial actions." 42 U.S.C. § 9613(k)(2)(B). Congress mandated that these procedures include: (1) notice to potentially affected persons accompanied by a brief analysis of the plan and an explanation of alternative plans that were considered; (2) a reasonable opportunity for the public to comment and provide information regarding the proposed remedial plan; (3) an opportunity for a public meeting in the affected area; (4) a mandatory response to each of the significant comments, criticisms, and new data submitted in written or oral presentations; and (5) a statement of the basis and purpose of the final selected action. Id.

The National Contingency Plan provides specific detailed guidelines that the EPA must follow to determine an appropriate remedial action for a site. These guidelines require preparation and use of a remedial investigation ("RI") and feasibility study ("FS") for each site, detailed discussion of certain alternatives and factors to be weighed with respect to each alternative within the FS, an opportunity for interested persons to comment on the adequacy and conclusions of the FS, and an EPA response to comments and criticisms from interested persons regarding possible remedial alternatives. See 40 C.F.R. § 300.430(e). After full consideration of the FS, a two-step process must be used to select the most appropriate remedy. First, the lead agency's preferred alternative is presented to the public for review and comment. Second, the lead agency must review and consider all comments to determine if the preferred alternative remains appropriate. Id. § 300.430(f)(1)(ii). The agency must document the rationale for its decision in a "Record of Decision." Id.

In contrast, CERCLA § 113(k)(2)(A), which addresses removal actions does not mandate specific public participation requirements, but does command the President to promulgate regulations establishing procedures for the appropriate participation of interested persons in the development of the administrative record on which the President will base the selection of removal actions. See 42 U.S.C. § 9613(k)(2)(A). Despite § 113(k)(2)(A)'s language indicating that participation in developing the record is supposed to occur before the President selects a removal action, NCP requirements for environmental evaluation of alternative removal actions and opportunity for interested persons to comment upon proposed removal actions are significantly less than for remedial actions.

The amount of evaluation and public participation in the removal action decisionmaking process depends upon the EPA's determination as to the time permitted before the removal action "must be" taken. The NCP provides that "[w]henever a planning period of at least six months exists before on-site activities must be initiated, and the lead agency determines, based on a site evaluation, that a removal action is appropriate: (i) the lead agency shall conduct an engineering evaluation/cost analysis (EE/CA) or its equivalent. The EE/CA is an analysis of removal alternatives for a site . . .." 40 C.F.R. § 300.415(b)(4). The EPA then must provide a public comment period on the EE/CA of not less than 30 days, with an automatic 15 day extension upon request, and prepare a written response to all significant comments. Id. § 300.415(m)(4)(iii)-(iv).

If the EPA, however, unilaterally decides, without the benefit of outside comment, that a site requires remediation within 6 months, the NCP requires no pre-action formal environmental evaluation or opportunity for public comment before the actions are ordered or undertaken. Nonetheless, OSWER Directive 9318.0-05 states "that an analysis of alternatives is performed for all removal actions, although it need not be extensive if time constraints preclude detailed analysis." Id. at 6 (emphasis original). The Administrative Record for the Site does not reveal any consideration of remedial alternatives other than those required by the Amended Order.[9]

The NCP lists several factors to be considered in determining whether removal (versus remedial) action should be ordered at a facility. Such factors include: the actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants; actual or potential contamination of drinking water supplies or sensitive ecosystems; whether high levels of hazardous substances or contaminants in soils, largely at or near the surface, exist which may migrate; etc. 40 C.F.R. § 300.415(b)(2).

The evidence contained in the Administrative Record does not justify the Amended Order's required immediate removal action. As previously demonstrated, evaluation of the conditions at the Site demonstrate that an imminent and substantial endangerment to public health and welfare and the environment does not exist, and therefore the Amended Order is not even validly issued under CERCLA § 106(a). Even if this threshold requirement were met, evaluation of the factors listed in NCP § 300.415(b)(2) demonstrates that the stricter requirements for finding that removal action is required at the Site clearly is not met. As set forth above, the Administrative Record in fact supports a finding that conditions at the Site pose absolutely no credible threat to human health, no threat to drinking water supplies, no threat to "sensitive ecosystems," and very little

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9. CERCLA § 101(24), which defines "remedial action" explains that the term includes such measures as: . . . dredging or excavations." 42 U.S.C. § 9601(24). Thus, based on the statutory definition itself, the excavation and dredging required by the Amended Order appear to properly be classified as "remedial" actions.

risk to the environment.[10] Likewise, the chemical nature of DDT and remedial measures previously implemented by Levin prevent migration from contaminated soils and sediments. Careful evaluation of every other factor listed in the NCP at 40 C.F.R. § 300.415(b)(2) similarly demonstrates that there is no justification for employing removal (rather than remedial) actions at the Site.

Evaluation of Site conditions under the EPA's own guidelines demonstrates that even if removal actions were required, it would have to be classified as Non-Time-Critical. The EPA has stated that a "Non-Time Critical Removal Action" is one where "initiation of removal cleanup on stabilization actions may be delayed for six months or more following approval of the action memo." OSWER Directive 9318.0-05 at 3. The two primary considerations in determining whether a site response can be delayed are the stability of the wastes and the potential for public contact with the wastes.[11] Id.

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10. The Administrative Record states that the California Department of Fish & Game informed EPA's contractor that "there are no known environmental receptors (e.g. wetlands, critical habitats, endangered species, nature preserves, etc.) near the United Heckathorn site." A.R. 7 at 3-1.

11. OSWER Directive 9318.0-05 describes three separate categories of removal actions, and gives examples of each type:

    (1) Classic Emergency Removal Actions - initiated in response to a release or threat of release that poses a risk to public health or welfare or the environment, such that the OSC determines that cleanup or stabilization actions must be initiated within hours or days after completion of the preliminary assessment . . . Such actions could include, but are not limited to, response to a fire in a chemical warehouse, response to a tanker truck accident that releases hazardous substances, or response to leaking drums that pose an explosion hazard.

    (2) Time-Critical Removal Actions - initiated in response to a release or threat of release that poses a risk to public health or welfare or the environment, such that cleanup or stabilization actions must be initiated within six months following approval of the action

As previously demonstrated, the chemical nature of DDT, the gravel cap, and anti-erosion efforts on the embankment ensure that the DDT at the Site is stable and virtually immobile. Moreover, the potential for public contact with contaminated soils and sediments has virtually been eliminated by fencing, signs, 24-hour security, gravel or asphalt cap, and the heavy industrial nature of the Site. The example under OSWER Dir. 9318.0-05 most similar to conditions at the Site is the "abandoned industrial dump" described as warranting a Non-Time-Critical Removal Action. <u>See</u> footnote 11, supra. Conditions at the Site, however, are not even as severe as that example because there is no potential threat of contamination to groundwater at the Site.

Careful scrutiny of the EPA's determination of the urgency required for any response action is also required to comply with the dictates of the National Environmental Policy Act ("NEPA"), which requires federal agencies to prepare an Environmental Impact Statement for all "major Federal actions significantly affecting the quality of the human environment." The EPA believes NEPA's requirements are met for remedial actions by the RI/FS process and for "Non-Time-Critical Removal Actions" (<u>i.e.</u> six months before on-site activity) by the EE/CA process of

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> memo. . . . Examples include response to an industrial site in a residential area containing open tanks of hazardous substances and spilled materials, response to a facility containing eroding unlined waste lagoons, or response to an unregulated waste dump containing scattered piles of deteriorating drums.
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> (3) <u>Non-Time-Critical Removal Actions</u> - initiated in response to a release or threat of release that poses a risk to public health or welfare or the environment, such that <u>initiation of removal cleanup or stabilization actions may be delayed for six months or more</u> following approval of the action memo. . . . An example of a Non-Time-Critical Removal Action might be response to an abandoned industrial dump, isolated from public access, which poses a potential threat to groundwater if not cleaned up. . . . The two primary considerations in determining whether site response can be delayed are the stability of the wastes and the potential for public contact with the wastes. . . .

<u>Id</u>. at 2-3 (emphasis original).

environmental review, consideration of alternatives, and opportunity for public comment. OSWER Dir. 9318.0-05 at 2-3. For "emergency" actions and "time-critical removal actions" (i.e. less than six months before on-site action), however, the EPA views itself as exempt from NEPA's requirement of environmental impact review. Id. at 3.

The Administrative Record provides no basis for the Amended Order's conclusion that a removal action at the Site must be commenced not just within six months, but within 2 days of receipt of the Original Order. The EPA failed to take any response action at the Site for over four years despite its knowledge of contamination there. The EPA's sudden assertion of an "emergency" at the Site, which conveniently avoids the environmental evaluation and public comment requirements of CERCLA, NEPA, the NCP, and the EPA's own Directives, is arbitrary, capricious, and contrary to law. The EPA itself apparently recognized this fact by issuing the Zelikson January 31, 1991 letter, which suspends the Amended Order's requirements for removal of contaminated sediments at the Site until a formal EE/CA report can be completed. See Exhibit 1 at 2-3.

OSWER Directive 9360.0-03B provides that, "[o]nce it has been determined from the results of the preliminary assessment that a removal action should be initiated, the OSC must document that the release meets the criteria in Section [300.415] of the NCP." Id. at III-16. The Administrative Record, however, contains no evidence whatsoever that the OSC evaluated the criteria in Section 300.415 of the NCP and objectively determined that a removal action, rather than remedial action, was required.

The Administrative Record also fails to support the Amended Order by failing to include any documentation whatsoever that indicates that alternative response actions were considered and that conditions at the Site justify the Amended Order's selection of excavation of contaminated soils and dredging of contaminated sediments. Under the NCP, a primary purpose of an Administrative Record is to disclose "the documents that form the basis for the selection of a response action." 40 C.F.R. § 300.800(a); id. § 300.810(a)(1). At best, the Administrative Record contains information that the EPA asserts establishes a need for response actions at the Site; the Administrative Record contains no documentation supporting the Amended Order's selection of the required remedial actions.

CERCLA, NEPA, the NCP and the EPA's own guidelines require environmental evaluations of alternative response actions and careful consideration of public comments on such proposals whenever possible. Such laws and regulations are intended to ensure that the environment and public are not harmed by the hasty pursuit of an ill-studied response action. Failure to carefully evaluate current site conditions and potential adverse effects of alternative response actions can result in significant harm to the very interests that the EPA is entrusted to protect. Adherence to the RI/FS process for remedial actions, which surely is appropriate for the Site, or at least the EE/CA process for Non-Time Critical Removal Actions, would have allowed the EPA to avoid issuing an Amended Order that:

(1) failed to specify means by which to remove sediments from the Lauritzen Canal;

(2) failed to specify any method by which to treat and dispose of dredged sediments;

(3) failed to require "Respondents" to devise a plan for EPA's review regarding either of the above;

(4) failed to specify any method by which to prevent the resuspension and migration of contaminated sediments during dredging;

(5) failed to identify the depth of contaminants in the sediments, so that the amount of sediments to be dredged could be estimated;

(6) failed to identify the types of contaminants in the sediments so that the risks of resuspension and dissolution, and proper treatment and disposal, could be properly considered;

(7) failed to determine whether the Lauritzen Canal sediments are a source or recipient of DDT in the water column;

(8) failed to determine whether all other sources of DDT and other contaminants to the Canal have been or would be eliminated so that it could be determined whether the sediments will likely be re-contaminated;

(9) failed to quantify the risk to human health and environment posed by the Site so as to permit that risk to be weighed against the environmental risks posed by the Amended Order's selected remedial actions.

Certainly, the current conditions at the Site do not justify the EPA's failure to take a deliberate, well-reasoned and thoroughly-considered approach toward addressing the contamination at the Site.

D. The Administrative Record Does Not Support the Amended Order's Conclusion That Excavation and Dredging of Contaminated Materials From the Site is Appropriate and Consistent with the National Contingency Plan

In determining whether the Amended Order's insistence that Montrose "remove all pesticide contaminated soils and sediments with a total DDT concentration equal to or above 100 parts per million from the upland, embankment and Lauritzen Canal areas that are contiguous with the visible cream-colored chemical residue on the Lauritzen Channel embankment" is valid under CERCLA § 106(a) and consistent with the NCP, the remedies selected for each purported choice of release or threatened release of DDT must be examined. The Administrative Record supports neither the selection of excavation as the appropriate remedy for contaminated soils in the upland and embankment areas, nor the selection of dredging as the appropriate remedy for contaminated sediments in the inter-tidal and sub-tidal areas of the Lauritzen Canal.

1. Containment, Not Removal, Is the Appropriate Remedy for Contaminated Soils.

The Amended Order requires excavation and disposal of soils contaminated with 100 ppm or more total DDT. Neither the Amended Order nor the Administrative Record reveals the reasons that the EPA ordered removal rather than containment of such contaminated soils. Indeed the removal required by the Amended Order is inconsistent with the Amended Order's finding that, to prevent harm, "it is necessary that actions be taken immediately to contain and prevent the release" of contaminants from the Site. Amended Order at 9 (emphasis added). In addition, neither the Amended Order nor the Administrative Record explains how the contaminated soils pose an imminent and substantial risk to human health or the environment.

Direct human or wildlife contact with contaminated soils is unlikely. The Site is located in an industrial area. A.R. 18 at 60. The Site is fenced and posted, and Levin personnel are present on a 24-hour basis, greatly reducing the potential of unauthorized access to the Site. A.R. 18 at 61. There are no boat ramps or other public shoreline facilities that permit direct access to the Lauritzen Canal. A.R. 18 at 61.

Moreover, most of the Site has been covered either with gravel fill or asphalt. See A.R. 7 at 2-8, 2-11, 4-1, 5-1; A.R. 12 at II-5, A.R. 13 at 2-4; A.R. 17 at 2; A.R. 35 at 10. The area around the former United Heckathorn facility has been cordoned off. A.R. 7 at 2-8. Any remaining risk of direct contact with contaminated soils could have been remedied by signs forbidding access to the area of the so-called "hot spot" addressed by the Amended Order.

As discussed above, the contaminated soil poses no risk through the pathway of airborne release. Air sampling at the Site revealed DDT concentrations far below levels having any potential adverse effect. See A.R. 12 at VII-2; A.R. 14 at 24, Table 1; A.R. 18 at 3, 31-32, 66; A.R. 35 at 51, 79; A.R. 36, App. D, 1983 Air Monitoring Survey at 1, 3. The EPA's contractors recognized that the existence of the gravel cap on the Site would reduce airborne releases because contaminated soil is no longer directly exposed to the air. A.R. 12 at IV-2 to IV-3. Dr. Freed has explained that the "low vapor pressure and adsorption of soil accounts for the very low amount of DDT found in the air samples at the Site." Freed Comments at 5. Assuming that additional control of airborne emissions from contaminated soil was required, despite the contrary evidence cited above, all such releases could have been prevented by placing a soil, fabric, or asphalt cover over the contaminated soils. See, e.g., Freed Comments, Appendix 1 at 5.

Also as discussed above, contaminant soils posed no substantial risk of harm to human health or the environment through the groundwater pathway. The Administrative Record reveals that the groundwater is not used for drinking. See A.R. 7 at 3-1 to 3-2; A.R. 17 at 29-30; A.R. 35 at 30. The Administrative Record reveals that "[c]hlorinated pesticides were generally detected at concentrations a few parts per billion or less in groundwater samples" from the Site. A.R. 18 at 29. This is consistent with the "extremely low solubility of DDT, DDD and DDE, and the high sorption coefficients which these chemicals have for soils at the Site." A.R. 18 at 29. The supplemental material to the Administrative Record demonstrates that groundwater seepage to the Lauritzen Canal is inconsequential considering the low pesticide concentration in the groundwater, the minimal rate of seepage to the canal, and the extremely high dilution factor. See A.R. 35 at 33, 79, 82. Moreover, DDT is not leaching from contaminated embankment soils to the Lauritzen Canal. A.R. 35 at 83. The only potential risk posed by DDT contaminated soil is that erosion of the embankment will deposit DDT residues into the Lauritzen Canal. The Administrative Record recognizes that "[s]teel and timber retaining walls have been installed along much of the landward side of the wharf as an interim measure to reduce erosion of the embankment and upland area." A.R. 17 at 2. Any remaining erosion could have been halted through containment measures as opposed to excavation.

To determine whether excavation of the contaminated soils is appropriate, it is necessary to balance the risk of harm posed by the contaminated soil against the risk of harm that may result from the proposed remedial action. As discussed above, the risk of harm from the contaminated soil is minimal. Excavation, at least until the gravel cover was replaced, would expose contaminated soils to direct human contact, possible air releases, and a greater risk of storm water runoff. See Freed Comments at 7. Although these risks are minimal, the EPA has provided no rationale for the selection of excavation, which poses these risks, over containment, which does not pose these risks, as a means of eliminating whatever minimal risk may be posed by the contaminated soil.

2. Dredging Is An Inappropriate Measure to Remedy Whatever Risk May be Posed by Contaminated Sediments in the Lauritzen Canal

The Amended Order requires removal of sediments in the Lauritzen Canal containing 100 ppm DDT or above that are contiguous with cream-colored residue on the Lauritzen Canal embankment. Amended Order at 11. Again, the Amended Order and Administrative Record fail to demonstrate the specific risk posed by the intertidal and subtidal sediments of the Lauritzen Canal that purportedly necessitates remediation. Parametrix Comments demonstrate that DDT contained in the Lauritzen Canal subtidal sediments poses no risk of harm to human health or the environment absent resuspension by some outside disturbance.[12] Contrasted against this minimal risk must be the potential adverse environmental impacts from dredging the sediments.

In 1986, the EPA's contractor recommended that dredging in the Lauritzen Canal immediately be halted. A.R. 7 at 8-1. The studies of dredging in the Administrative Record, apparently placed there by the EPA to support selection of its dredging alternative, in fact demonstrate the adverse effects of dredging.

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12. The EPA's contractor noted that "DDT may not be extracted from the canal sediments unless exposed to a solvent or fatty-acid-type substance. The chances for an oil spill or acid spill occurring [in the Lauritzen Canal] are remote. . . ." A.R. 7 at 7-1.

The Army Corp of Engineers study, "Environmental Effects of Dredging," was undertaken to discuss the "size and concentration of sediment plumes measured in field studies of selected dredging equipment." A.R. 11 at 1. The Corp noted that this "information is useful when sediment resuspension must be minimized because of <u>adverse environmental impacts which may include the release of sediment-associated chemical contaminants</u>." <u>Id</u>. (emphasis added). Recognizing that certain chemicals cling to sediments, the Corp stated that "the release of hydrophobic (strongly adsorbed) chemicals can be evaluated by examining the transport of resuspended sediments. The release of poorly adsorbed chemicals to the water column is a more complex problem because these contaminants can disassociate from sediment particles." <u>Id</u>. The remainder of the Corp's discussion considered the <u>extent of resuspension</u> of contaminated sediments; nowhere does it state that such resuspension and migration can be prevented. A.R. 11; <u>see</u> <u>also</u> A.R. 8.

A textbook authored by scientists at the US Army Corps of Engineers Waterways Experiment Station explains that, before performing dredging of contaminated sediments, three areas of substantial risk for contamination should be carefully evaluated: (1) resuspension during dredging; (2) potential release during transport; and (3) potential release after disposal. <u>See</u> Exhibit 7 at 8, 459. The text states positively that "[d]uring dredging operations <u>all</u> dredge plants, to differing degrees, disturb bottom sediment, causing a plume of suspended solids around the dredging operation." Exhibit 7 at 12 (emphasis added). The text also explains that so long as contaminated sediments remain in an aquatic environment, sediment chemistry may not change; however, transfer of contaminated sediments to a dryer environment, such as an upland disposal site, may change the chemistry to a condition more favorable to the release of such contaminants. Exhibit 7 at 7.

Further explanation of the hazards of dredging contaminated sediments is set forth in an article by Professor W. Andrew Marcus, "Managing Contaminated Sediments In Aquatic Environments: Identification, Regulation, and Remediation," 21 E.L.R. 10020 (1991), attached hereto as Exhibit 8. Professor Marcus notes that:

> The biggest environmental problem associated with dredging of contaminated sediments is resuspension of the sediments and the resulting loss of volatiles and solubles to the water column. Re-suspension occurs due to dredge action at the sediment-water

> interface, during transfer of the sediment to a storage vessel, due to slop or leakage from the vessel, and during disposal. . . . The price of contaminated dredge removal can pose obstacles, with costs ranging from $11.50 to $23.00 per cubic yard, as compared with $1 to $2 per cubic yard for removal of clean sediments. . . . A major concern in transporting the dredge material is spillage, particularly during loading and unloading operations. In some cases, decontamination of sediment-handling equipment is required. Chemical changes during transport are also a concern. Dewatering, for example, can lead to oxidation of sediments and increased solubility of the contaminants at the disposal site.

Exhibit 8 (21 E.L.R. at 10031).

The State of California specifically recognized that the "DDT-laden sediment within the [Lauritzen] Canal could have been disturbed by the shipping and dredging activities that occur regularly within the Canal." A.R. 6 at 45. The difficulties and risks of dredging, and the difficulties and risks of treating and disposing of the dredged sediments, is further discussed in the Parametrix Comments. It should be emphasized, however, the DDT-contaminated sediments resuspended by dredging will pose a risk to aquatic life. Not only will the dredging resuspend sediments in the Lauritzen Canal, but Parametrix estimates that 75% of the resuspended sediments will migrate into the Santa Fe Channel. In fact, the Administrative Record indicates that the Lauritzen Canal sediments "consisted of a black, very soft silty clay," A.R. 18 at 14, which likely indicates resuspended sediments will be conducive to migration. The supplemental material to the Administrative Record directly states that dredging the canal will probably cause redistribution and migration of contaminated sediments to adjacent waterways. A.R. 35 at 113.

The supplemental material to the Administrative Record is replete with evidence that there has not been sufficient evaluation of either the risks posed by the sediments at the Site in their current state or the risks posed by dredging these sediments. The Revised Draft Site Characterization and Remedial Action Plan plainly admits that it is "uncertain" whether the contaminated sediments pose a (long-term) environmental risk. A.R. 37 at 4, 85, 113; (although the short-term environmental risk is evaluated to be none, A.R. 35 at 113). Despite the

Amended Order's assertion that the sediments "pose an imminent and substantial threat to the marine food chain in the San Francisco Bay environment", the supplemental material candidly admits that during biological studies at the Site "no attempt was made to assess the effects on the Richmond Harbor or San Francisco Bay ecosystems." A.R. 35 at 52. A DHS Evaluation Report critically states that additional data are needed to describe the environmental processes affecting the distribution of contaminants, such as water column concentrations, inorganic/organic DDT concentration ratio in sediments, and contaminant levels in representative biota. A.R. 37 at 4-11 to 4-12. The DHS report explains that "this information, in addition to a detailed understanding of the toxicity of DDT is <u>necessary to evaluate the potential impact of remedial action alternatives</u>." A.R. 35 at 4-12 (emphasis added). Since the risks associated with the Site condition have not been adequately assessed, "it is not possible to evaluate the effectiveness of the proposed actions in reducing risk." A.R. 37 at 7-4.

Likewise, the Revised Draft Site Characterization and Remedial Action Plan states that the risk of exposure of aquatic species to contaminated sediments which will be resuspended during the ordered dredging operation is uncertain. A.R. 35 at 115, 117, 123. The DHS Evaluation Report states that "before proceeding with further actions at this site" the "environmental and public health risks associated with dredging the canal should be analyzed." A.R. 37 at 7-2. The DHS report concludes that "the lack of an objective for the offsite cleanup actions provides no basis to determine what effect the proposed [dredging] action would have on the biota of Richmond Harbor if the action were implemented", A.R. 37 at 7-4, and "natural and man-induced forces that act to redistribute the sediments . . . need to be quantified to compare the impacts associated with no action and those associated with capping or dredging." A.R. 37 at 6-4.[13/]

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13. Montrose suggests that, to ensure adequate protection of the environment, the EPA should cast a skeptical eye on reports by Levin consultants that propose dredging as the favored remedial action. For example, the Revised Draft Site Characterization and Remedial Action Plan, prepared on behalf of Levin, states that "no action" to the sediments poses no short-term or long-term human health risks, no short-term environmental risks, and "uncertain" long-term environmental risks. Moreover, the request states that "redistribution and migration [of contaminated sediments] to adjacent waterways . . . would probably occur during

In addition to a lack of information concerning the risks of dredging, the Administrative Record does not address the following fundamental questions: (1) Are there any other sources of DDT into the Lauritzen Canal such that sediments will become recontaminated and render the dredging of contaminated sediments of little or no value? (2) To what depth are the sediments contaminated with DDT concentrations eliciting concern? Sampling of the Lauritzen Canal sediments has not been comprehensive and is almost non-existent below a depth of 36 inches. The DHS Evaluation Report in the supplemental material to the Administrative Record indicates a "major deficiency" has been the failure to identify "the extent of DDT contamination in the sediments, particularly with depth in the northern portion of the canal and laterally in the southern portion." A.R. 37 at 6-4. Neither Montrose nor apparently the EPA have the slightest idea of the extent of sediments conceivably subject to the Amended Order. Although the sedimentation rate in the Lauritzen Canal apparently is unknown, 26 years have passed since the Heckathorn facility ceased operations.

The Amended Order and the Administrative Record fail to consider any other alternative for remediating any potential risk posed by the Lauritzen Canal sediments. Various possible alternatives are discussed both in the Parametrix comments and Exhibit 8. The "no action" alternative would simply permit natural sedimentation to bury and contain the DDT-contaminated sediments. Given the low risk posed by DDT contamination in the sediments, _see_ Parametrix Comments, this alternative is viable so long as other sources of DDT into the Canal have been eliminated and disturbance of the Canal, either by boat traffic or dredging, is avoided. EPA Handbook: Responding to Discharges of Sinking Hazardous Substances (1987) notes that an "example of a situation

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dredging of the sediment." A.R. 35 at 113.

The report's illogical conclusion that dredging is an appropriate remedy can only be explained by the fact that "leaving the sediments in place would limit [Levin's] options for use of this portion of the canal because it is too shallow to accommodate the type and size of ships used by [Levin]." A.R. 35 at 113. Montrose respectfully suggests that Levin's desire to acquire an additional shipping berth should not be allowed to impose "uncertain" and potentially substantial damage on the environment, and that costs incurred merely to benefit Levin's commercial interests should not be shifted to other Respondents.

where the decision might be made 'no action is best' would be where the only applicable response category is removal, but all removal techniques would resuspend contaminated, highly toxic material, thus creating a greater hazard than the hazard that existed previously." Id. at 4-5; accord id. at 4-6.

The National Research Council, Committee on Contaminated Marine Sediments concluded at a symposium in 1989 that "'[n]o action' may be the preferred alternative in cases in which the remedy may be worse than the disease -- e.g., where dredging or stabilizing contaminated sediments results in more biological damage than leaving the material in place." National Research Council, Contaminated Marine Sediments - Assessment and Remediation (Nat'l Acad. Press 1989) at 14 (attached hereto as Exhibit 9). The Committee explained that "[c]ontaminants generally accumulate in depositional zones, and, if the source is controlled, new sediments will deposit and cap the contaminated material over time. In effect, no action alternatives in such cases may result in natural capping." Id.

Another possible alternative is in-situ containment of the contaminated sediments. Contaminated sediments can be capped with either clean sands or silt. Exhibit 8 (21 E.L.R. at 10030). A rock layer may be placed over a sand cap to protect against disturbance by boat traffic and storm drains into the Lauritzen Canal, and to provide a favorable environment for aquatic biota. See Parametrix Comments; Exhibit 8 (21 E.L.R. at 10030).

Montrose believes that the Administrative Record and the Parametrix Comments establish that DDT contamination in the Lauritzen Canal sediments do not pose a substantial risk that justifies taking emergency action before the scope and type of contamination is adequately characterized, it is adequately determined that the Lauritzen Canal is a source of DDT releases into the environment, and adequate consideration to possible remedial alternatives is given. See Handbook at 4-1.

Neither the Amended Order nor the Administrative Record demonstrate thorough analysis of or concern for the risks attendant to dredging contaminated sediments in the Lauritzen Canal. The Amended Order does not specify the method for dredging the contaminants, does not specify the methods for transporting the dredged material, and does not specify the method for treating and disposing of the dredged sediments. Yet, the Amended Order requires Respondents to commence removal of contaminated sediments "below mean low water" within sixty days. Amended Order at 13 (A.R. 50). Although a sixty-day period is substantially longer than was provided in the Original Order, the

Amended Order still provides inadequate time for development of the most environmentally-protective plan for dredging (as admitted by the Zelickson January 31, 1991 letter), much less sufficient time to ascertain whether dredging itself is environmentally safe.

On the Administrative Record, the EPA's Amended Order is arbitrary, capricious, inconsistent with the NCP and otherwise contrary to law and regulation.

Very truly yours,

Richard W. Raushenbush
of LATHAM & WATKINS

Enclosures

cc: Frank C. Bachman
Geoffrey R. Kors, Esq.

Exhibit List

1. January 31, 1991 letter from Jeff Zelikson, Director, EPA's Hazardous Waste Management Division to Mr. Frank Bachman, Montrose Chemical Corporation [sic].

2. October 11, 1990 letter from Richard W. Raushenbush, representing Montrose to Geoffrey R. Kors, Esq., representing the EPA.

3. October 23, 1990 letter from Richard W. Raushenbush, Esq. representing Montrose to Richard Wm. Martyn, Esq. representing the EPA.

4. October 24, 1990 letter from Geoffrey R. Kors, representing the Environmental Protection Agency, to Richard W. Raushenbush, Esq. representing Montrose.

5. November 27, 1990 letter from Jerry Clifford, Deputy Director for Superfund, EPA's Hazardous Waste Management Division to Albert C. Perrino, President, Montrose Chemical Corporation of California (selected portions).

6. U.S. EPA, "Ambient Water Quality Criteria for DDT", EPA 440/5-80-038 (October 1980) (selected pages).

7. Cullinane et al., Pequegnat, Contaminated Dredged Material - Control, Treatment and Disposal Practices (1990) (selected pages).

8. Marcus, W. Andrew, "Managing Contaminated Sediments In Aquatic Environments: Identification, Regulation, and Remediation," 21 E.L.R. 10020 (1991).

9. National Research Council, "Contaminated Marine Sediments - Assessment and Remediation" (Nat'l Acad. Press 1989).

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105

RECEIVED
FEB 5 1991
LATHAM WATKINS
SAN DIEGO

31 JAN 1991

CERTIFIED MAIL P 538 027 065
RETURN RECEIPT REQUESTED

Mr. Frank Bachman
Montrose Chemical Corporation
830 Post Road East
Westport, CT 06880

Re: Order No. 90-22 pursuant to 42 U.S.C. Section 9606, as amended, regarding United Heckathorn, 402 Wright Avenue Richmond, California

Dear Mr. Bachman:

On September 28, 1990, the Environmental Protection Agency (EPA) issued EPA Order No. 90-22 to Levin Richmond Terminal Corporation, Parr Richmond Terminal Corporation, Montrose Chemical Corporation and Shell Oil Company. The Order was amended on October 23, 1990 to include Chemwest, Levin Enterprises and Rhone-Poulenc Basic Chemical Company. This letter is notification to the above respondents of noncompliance with EPA Order No. 90-22, as amended.

Among other requirements, EPA Order No. 90-22 directed the respondents to provide improved site security, conduct additional sampling, implement approved safety and work plans with modifications and to provide a schedule for engineering design and removal of contaminated sediments within the Lauritzen Canal.

Although excavation of the embankment and upland hotspot areas was ordered to commence on October 22, 1990, it did not begin until the week of November 5, 1990. On-scene Coordinator (OSC) Brad Shipley also observed minor safety infractions, unattended problems with the sediment curtain and inadequate site security, as documented in his memo to Allan Leavitt on Nov. 30, 1990. As a result of the delay, contaminated material prohibited from land disposal is now temporarily stockpiled at the Site and more remains to be removed in the upland area adjacent to and contiguous with material excavated from the embankment area.

The OSC agreed to allow excavation to begin without removal of the scrap metal crane perched above the excavation area so that the majority of contaminated material from the embankment could be removed and disposed of before Nov. 8, 1990. This agreement was made with the understanding that the crane, and contaminated material beneath it, would be removed, excavated and properly disposed of immediately following removal of embankment material. Although the crane has been removed, contaminated material with DDT concentrations greater than 100 ppm, contiguous with visible cream-colored chemical residue, still remains in the upland area. The OSC was told by Levine-Fricke, the contractor performing the removal actions at the site, that the extent of this material needs further characterization but that they have no authorization from the Respondents to do this work. This material was clearly included in phase I excavation activities Ordered to commence on October 22, 1990. Requests for a plan and schedule addressing this remaining upland hotspot area and stock-piled material have not been answered. Due to the lack of action by the Respondents in addressing the remaining phase I material, the OSC has determined that the respondents have not complied with EPA Order 90-22, as amended.

EPA hereby orders the Respondents, at the very minimum, to provide a proposal for completing the removal of the upland "hotspot" area. This proposal must include a work plan, schedule and cost estimate for assessing, excavating and disposing of all contaminated material considered part of phase I removal activities. Respondents will remain in non-compliance until all phase I activities are completed.

Phase II of the EPA ordered removal addresses contaminated sediments below mean low water. A schedule for removal of these sediments was received as requested in the Order, as amended. As a result of comments from Levine-Fricke, Latham & Watkins, counsel for Montrose Chemical Corporation, and additional technical information, the OSC determined that the time frame for sediment removal, as specified in the Amended Order, should be altered. The OSC also determined that a planning period of at least six months would be required to resolve all the issues, concerns and technical aspects of dredging sediments from Lauritzen Canal in an EPA Ordered removal action. This "non-time critical" determination requires that a formal Engineering Evaluation/Cost Analysis (EE/CA) report be completed prior to implementation of the chosen remedy.

The OSC notified Allan Leavitt of Levine-Fricke on November 26, 1990 to suspend phase II activities, described in paragraph V.E.4 of the Amended Order. As stated in the OSC's memo to Mr. Leavitt on Nov. 30, 1990, phase I activities and dates remain unchanged and EPA will clarify its expectations for phase II when phase I has been completed. The OSC subsequently requested the phase II work plan because he was informed it was completed and ready to be submitted as scheduled. The OSC suggested that the existing work plan be used as a template for an expanded phase II work plan since many of the specific elements will be the same. The three page, draft phase II work plan has not been received by EPA.

This letter officially suspends EPA Amended Order 90-22 requirements for removal of contaminated sediments below mean low water in the Lauritzen Canal, as provided in section V.E.4. EPA will contact you shortly regarding future removal activities at the site. However all other portions of the Amended Order remain in effect.

The OSC has received several requests to clarify EPA's opinion on the adequacy of site security. In general, the OSC is sensitive to the fact that the site is heavily used for terminal operations. Although activities at the terminal should not disturb contaminated materials, workers have exhibited a lack of respect for the threat that the situation poses. The specific area of excavation and remaining material is not adequately secured to prevent personnel from unknowingly wandering into it. The fence along So. 4th Street is adequate in preventing public access when the gates are locked. However, the OSC and Technical Assistance Team members have frequently walked through unlocked gates, unopposed; therefore it is doubtful that the 24 hour presence at the weigh station provides adequate site security. At a minimum, personnel at the site need to improve awareness of the situation, the northern most gate must be locked during the day when not in use and isolation of the excavation area must be improved.

Please direct any technical questions about the Order to Brad Shipley at 415-744-2287 and any legal questions to Geoff Kors at 415-744-1311.

Very truly yours,

Jeff Zelikson
Director
Hazardous Waste Management Division

cc: Andrew Lincoff, EPA
Barbara Cook, DHS
Susan Gladstone, RWQCB
Mike Rugg, CDFG
Harry Demarest, NOAA
Richard Raushenbash, Latham & Watkins

2

LATHAM & WATKINS

ATTORNEYS AT LAW

701 "B" STREET, SUITE 2100
SAN DIEGO, CALIFORNIA 92101-8197
TELEPHONE (619) 236-1234
FAX (619) 696-7419
TLX 590778
ELN 62793276

PAUL R. WATKINS (1899-1973)
DANA LATHAM (1898-1974)

CHICAGO OFFICE
SEARS TOWER, SUITE 5800
CHICAGO, ILLINOIS 60606
TELEPHONE (312) 876-7700
FA (312) 993-9767

LOS ANGELES OFFICE
633 WEST FIFTH, SUITE 4000
LOS ANGELES, CALIFORNIA 90071-2007
TELEPHONE (213) 485-1234
FA (213) 891-8763

NEW ORK OFFICE
53RD AT THIRD, SUITE 1000
885 THIRD AVENUE
NEW ORK, NEW ORK 10022-4802
TELEPHONE (212) 906-1200
FA (212) 751-4864

ORANGE COUNT OFFICE
650 TOWN CENTER DRIVE, TWENTIETH FLOOR
COSTA MESA, CALIFORNIA 92626-1918
TELEPHONE (714) 540-1235
FA (714) 755-8290

SAN FRANCISCO OFFICE
580 CALIFORNIA STREET, SUITE 500
SAN FRANCISCO, CA 94104
TELEPHONE (415) 391-0600
FA (415) 395-8095

WASHINGTON, D.C. OFFICE
1001 PENNS LVANIA AVE., N.W., SUITE 1300
WASHINGTON, D.C. 20004-2505
TELEPHONE (202) 637-2200
FA (202) 637-2201

October 11, 1990

VIA TELECOPY (Hard Copy in Mail)

Geoffrey Kors, Esq.
Office of Regional Counsel
U.S. Environmental Protection Agency
1235 Mission Street
San Francisco, California 94103

Re: In re United Heckathorn, EPA Order No. 90-22

Dear Mr. Kors:

On October 4, 1990, Robert P. Dahlquist and I, on behalf of Montrose Chemical Corporation of California ("Montrose"), met with you, Richard Martyn, and Andrew Lincoff, on behalf of the Environmental Protection Agency ("EPA"), regarding EPA Order No. 90-22 (the "Order"). Montrose's understanding of the issues raised at that conference and the EPA's responses thereto is as follows.

At the conference, we noted Montrose's surprise at the Order, given that the Site has existed since 1965, the EPA has known of the Site for many years without asserting any emergency exists at the Site, and Montrose was not invited to or present at any of the meetings between the EPA and Levin regarding remediation of the Site and the work required by the Order. You stated that the EPA had only taken over the Site in the last month, that on July 25, 1990 the EPA only told Judge Conti that it would be lead agency for the Site, not that it was lead agency at that time, and that the EPA's review of the Site led it to decide to issue the Order. At the October 5, 1990 conference with the EPA, attended by Robert Dell on behalf of Montrose, the EPA also asserted that the Order was issued in a manner consistent with the EPA's usual practice. The EPA's usual practice apparently is 24-hour deadlines and no prior notice to entities named in CERCLA § 106 orders.

At the conference, the EPA agreed that Montrose's alleged liability under CERCLA for remediation of the Site rests upon the theory set forth in United States v. Aceto Agricultural Chemicals Company, 872 F.2d 1373 (8th Cir. 1989). Montrose reiterated its position that the Aceto decision is contrary to the plain language of CERCLA and, in any event, is inapplicable to this case. Montrose also stated its belief that CERCLA § 106(a), 42 U.S.C. § 9606(a), does not authorize the EPA to issue administrative orders that purport to obligate multiple parties, jointly and severally, to perform certain work. The EPA disagreed. Montrose also stated its belief that the Order was invalid because of its failure to name as respondents all of the operators and owners of the Site as well as other parties similarly-situated to Montrose. The EPA asserted that it was not required to name all of the potentially responsible parties in the Order, but that it was willing to consider naming additional parties.

The EPA indicated that certain parties, such as Heckathorn, were not named because their financial situation. When questioned as to why the EPA named Montrose, which the EPA knows to have limited financial resources, the EPA responded that no entity was excluded from the Order for financial reasons alone. The EPA again stated that it was willing to consider naming additional parties if it had sufficient evidence to do so and requested that Montrose provide such evidence. Montrose then provided evidence regarding numerous parties not named by the EPA in the Order.

Montrose also discussed various provisions in the Order with the EPA. Section V(B) of the Order requires that "Respondents shall implement twenty-four (24) hour security at the Site which meets with EPA approval." Despite Montrose's protestations that it does not own or control the Site, the EPA informed Montrose that Montrose must ensure that security measures approved by the EPA are in place at the Site. The EPA informed Montrose that Levin had provided the EPA with information regarding security measures at the Site, but that the EPA had not determined if such measures were adequate and, in any event, would not notify Montrose whether such measures were adequate because the information was submitted by Levin alone and not in cooperation with Montrose.

Section V(C) of the Order requires that "Respondents shall restrict access to the Site to all personnel." Despite Montrose's protestations that it does not own or control the Site, the EPA informed Montrose that Montrose must ensure that access to the Site is restricted. Moreover, in response to

Montrose's questions, the EPA informed Montrose that the "Site" constituted the entire "United Heckathorn Site," not solely the area around the so-called "hot-spot," and that Montrose has a duty to prevent Levin's employees from entering the "Site." The EPA agreed to consider modifying the Order to restrict access only to the area of the so-called "hot-spot," but stated that, at the present time, access must be restricted to the entire "Site."

Section V(E)(3) requires that "Respondents shall commence the pre-excavation sampling and the demolition of the Levin pier over the area of visible cream-colored chemical residue on the Lauritzen Channel Embankment by October 4, 1990." Despite Montrose's protestations that it does not own or control Levin's pier, the EPA informed Montrose that Montrose is required to ensure that Levin's pier is demolished. The EPA, however, refused to indemnify Montrose for any claims by Levin that might result if Montrose were to demolish Levin's pier.

In response to Montrose's questions, the EPA indicated its belief that some dredging of the Lauritzen Canal would be required. Although Montrose protested that the effects of dredging and its disturbance of pesticide residues presently contained in sediments at the bottom of the Lauritzen Canal have not been studied and are unknown, the EPA insisted that Montrose comply with the requirement to remove all sediments containing DDT in excess of 100 ppm. When Montrose asked about alternatives to dredging, the EPA stated that, without dredging, the contaminants would be in contact with the San Francisco Bay and no one had agreed to Levin's plan to seal off the Lauritzen Canal with a dam. When Montrose questioned whether it would be necessary to dredge all of the Lauritzen Canal, the EPA indicated its belief that the area to be dredged would be confined to the area around the embankment near the cream-colored residue because, given that DDT is not soluble in sea water, most of the DDT probably remained in that area.

Montrose expressly requested the following modifications to the Order:

(1) The EPA add additional parties, including owners, operators, and, if the EPA intends to apply Aceto in the Ninth Circuit, other manufacturers similarly-situated to Montrose;

(2) Impose the burden of ensuring and limiting access to the Site, and supplying adequate security around the Site, on Levin alone because it is the only party that owns and controls the Site;

(3) Narrow the Order to require only the immediate removal of the cream-colored substance and the completion of sampling, which would then be followed by discussions regarding appropriate remedial measures; and

(4) Altering the deadlines set forth in the Order to meet the timetable that Levin's consultants believe can be met.

The EPA stated that Montrose has not complied with the Order because it has failed to given adequate notice of its intent to comply with the Order. Montrose referenced its position set forth in its October 3, 1990 letter. That letter states, in part, that "Montrose is willing to negotiate in good faith regarding compliance with the Order in cooperation with other parties in a manner commensurate with Montrose's exposure at the Site."

If you disagree with Montrose's understanding of the issues raised at the conference and the EPA's responses thereto, please contact me immediately. In addition, Montrose hereby requests that the EPA notify Montrose whether (1) Levin's existing security measures meet with the EPA's approval, (2) the EPA has added additional parties to the Order, and (3) the EPA has modified the Order in any respect. Montrose notes that, in light of the EPA's position at the conference, Montrose has written Levin to ascertain whether Levin is complying with the Order's requirements regarding security, access, and pre-excavation sampling at the Site and demolition of Levin's pier. See attached October 5, 1990 letter from Latham & Watkins to Roger B. Pool and Keith Howard, counsel for Levin.

Very truly yours,

Richard W. Raushenbush
of LATHAM & WATKINS

Attachment

cc: Frank Bachman

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LATHAM & WATKINS

ATTORNEYS AT LAW
701 "B" STREET, SUITE 2100
SAN DIEGO, CALIFORNIA 92101-8197
TELEPHONE (619) 236-1234
FAX (619) 696-7419
TLX 590778
ELN 62793276

PAUL R. WATKINS (1899-1973)
DANA LATHAM (1898-1974)

CHICAGO OFFICE
SEARS TOWER, SUITE 5800
CHICAGO, ILLINOIS 60606
TELEPHONE (312) 876-7700
FAX (312) 993-9767

LONDON OFFICE
12 COPTHALL AVENUE
LONDON EC2R 7DH ENGLAND
TELEPHONE 071-374 4444
FAX 071-374 4460

LOS ANGELES OFFICE
633 WEST FIFTH STREET, SUITE 4000
LOS ANGELES, CALIFORNIA 90071-2007
TELEPHONE (213) 485-1234
FAX (213) 891-8763

NEW YORK OFFICE
885 THIRD AVENUE, SUITE 1000
NEW YORK, NEW YORK 10022-4602
TELEPHONE (212) 906-1200
FAX (212) 751-4864

ORANGE COUNTY OFFICE
650 TOWN CENTER DRIVE, SUITE 2000
COSTA MESA, CALIFORNIA 92626-1918
TELEPHONE (714) 540-1235
FAX (714) 755-8290

SAN FRANCISCO OFFICE
580 CALIFORNIA STREET, SUITE 500
SAN FRANCISCO, CA 94104
TELEPHONE (415) 391-0600
FAX (415) 395-8095

WASHINGTON, D.C. OFFICE
1001 PENNSYLVANIA AVE., N.W., SUITE 1300
WASHINGTON, D.C. 20004-2505
TELEPHONE (202) 637-2200
FAX (202) 637-2201

October 23, 1990

BY TELECOPY (HARD COPY BY MAIL)

Mr. Richard Wm. Martyn
Federal On-Scene Coordinator
U.S. Environmental Protection Agency
75 Hawthorne Street
San Francisco, California 94105

Re: In re United Heckathorn, EPA Order No. 90-22

Dear Mr. Martyn:

We are writing on behalf of Montrose Chemical Corporation of California ("Montrose") in response to your October 18, 1990 letter to Albert C. Perrino amending EPA Order No. 90-22 (the "Order") regarding the United Heckathorn Site (the "Site"). This letter constitutes Montrose's response to the amendments to the Order.

Montrose incorporates herein all of its objections to the Order made in its October 3, 1990 letter to Jerry Clifford, Deputy Director, Superfund Hazardous Waste Management Division. As noted therein, Montrose denies any liability for conditions at the Site. Nonetheless, as before, Montrose is willing to negotiate in good faith regarding compliance with the Order in cooperation with other parties and in a manner commensurate with Montrose's exposure at the Site.

On October 17, 1990, representatives of Montrose met with representatives of the EPA, Levin, and Parr Richmond Terminal Company ("PRTC"). Levin's consultants, Levine Fricke, presented to the EPA a proposal to immediately remove certain contaminated soils from the upland and embankment areas, and perform additional testing in the Lauritzen Canal (the "Phase I" work), and to perform removal of contaminated sediments from the Lauritzen Canal after development of a work plan that will ensure that no contaminants would migrate during any dredging of such sediments (the "Phase II" work).

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Before that meeting, despite the fact that Montrose never owned, operated or disposed of waste at the Site, Montrose had agreed to contribute a one-fourth per capita share, up to but not exceeding $90,000, of the costs of the Phase I work and already performed pre-excavation testing, subject to Montrose's receiving no objection from its insurers. Montrose's commitment to pay up to $90,000 was based upon Levin's estimate of the costs of such work at $360,000 and the expectation that each of the four Respondents would fund a per capita share of such costs. Moreover, Montrose's willingness to make such a contribution was based upon its understanding that the planned Phase I work would comply with the soils removal aspects of the Order.

This was an extremely significant commitment for Montrose given its limited financial resources and was made solely because of the coercive threat of potential fines and treble damages for non-compliance with the Order. Montrose denies all liability for conditions of the Site and will reserve its rights to seek recovery of any response costs incurred by Montrose at the Site pursuant to CERCLA § 9612.

Since Montrose made that commitment, however, Levin's counsel has informed Montrose that neither Shell nor PRTC are willing or able to contribute toward the cost of any work at the Site. Moreover, Levin has revised its cost estimate to reflect the removal of all soils contaminated with DDT equal to or above 100 ppm, as insisted upon by the EPA. The new estimate is $370,000 for soils removal, for a total of $430,000 including past and contemplated testing in the Canal.

In addition, although Montrose has attempted in good faith to comply with the Order, the EPA has been unresponsive to Montrose's concerns. First, despite oral and written requests, the EPA has not informed Montrose whether Levin's existing security measures meet with EPA's approval. Second, despite Montrose's oral and written requests for modifications to the Order, the EPA has not responded to such requests. In particular, the EPA has not yet responded to Montrose's request that it name additional potentially responsible parties to share in the costs of the work required by the Order. Third, although the EPA apparently is processing Montrose's request, the EPA has not provided Montrose with the administrative record that purportedly justifies naming Montrose as a Respondent in the Order.

Montrose also raises the following additional objections to the "amended" Order:

(1) Based upon discussions with Levin and the opinion of Levin's consultants, Montrose believes that it is technically impossible to begin removal of the contaminated sediments within 60 days.

(2) Montrose is very reluctant to begin any excavation of the Lauritzen Canal embankment until a work plan has been developed that assures Montrose that the danger of the embankment collapsing can be prevented.

(3) Montrose is extremely reluctant to commit to any dredging of contaminated sediments in the Canal until a work plan has been developed that assures Montrose that such dredging can be conducted safely without permitting the migration of contaminants out of their present location in the Lauritzen Canal. Moreover, Montrose notes that the National Oceanic and Atmospheric Administration ("NOAA") inquired about possible natural resource damages resulting from the Heckathorn Site in February 1990. Given the potential risk that NOAA might choose in the future to assert natural resource damage claims against Montrose, and may base such claims upon any release that may result from dredging in the Lauritzen Canal, Montrose requests that the EPA agree to indemnify Montrose for all claims that may result from any dredging in the Lauritzen Canal.

(4) Montrose objects to the Order in that it fails to specify what areas must be excavated and/or dredged to comply with the Order.

(5) Montrose believes that the EPA's continued failure to include owners and operators of the Site, and other entities similarly-situated to Montrose, as Respondents to the Order, despite information provided to the EPA by Montrose and Levin, renders the "amended" Order even more arbitrary than the Order.

(6) As noted in Montrose's October 3, 1990 letter to Jerry Clifford, Montrose is not liable under CERCLA for conditions at the Site because it never arranged for disposal of wastes at the Site. Montrose is concerned, however, that any involvement in disposing of contaminated soils and sediments from the Site at some disposal facility may result in the EPA or some other party asserting CERCLA claims against Montrose if there

should be a release or threatened release from that disposal facility in the future. Therefore, Montrose requests that the EPA either confirm in writing its opinion that Montrose would not be liable for any such threatened release or release under CERCLA § 107(d)(1), 42 U.S.C. § 9607(d)(1), or agree to indemnify Montrose against any such claims.

Montrose offered, in good faith, to participate per capita with the other named Respondents in a proposal to complete the Phase I work and thereby comply with that aspect of the Order. Given that Montrose never owned, operated, or disposed of wastes at the Site, and is willing to comply with the Order solely because of its coercive aspects, only a per capita division of the costs is reasonable under these circumstances where neither liability nor an appropriate allocation of liability, if any, can be determined in a timely manner. The refusal of Shell and PRTC to participate in such work has made full performance of the Phase I work impossible at this time.

Montrose understands that the EPA intends to issue a revised Order adding additional parties as Respondents. Montrose stands ready to discuss a per capita participation in the full performance of the Phase I work with all Respondents to the Order.

Very truly yours,

Richard W. Raushenbush
of LATHAM & WATKINS

cc: Frank Bachman
Jerry Clifford
Geoffrey Kors, Esq.
Keith Howard, Esq.
Thomas Kearns, Esq.
Benjamin H. Ballard, Esq.

SD61\RWR\PARR\MARTYN.LTR

4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

October 24, 1990

VIA TELECOPY (and regular mail)
Richard Raushenbush
Latham & Watkins
701 B Street
Suite 2100
San Diego, CA 92101

Re: EPA Order No. 90-22

Dear Mr. Raushenbush:

This letter is in response to your letters to the Environmental Protection Agency (EPA) of October 3, 1990, October 11, 1990, October 16, 1990 and October 23, 1990. Many of the issues raised in your letters have already been discussed during the three meetings attorneys for Montrose have attended regarding this matter. Accordingly, this letter is not an attempt to address each and every item in your four October letters, but rather discuss the major points raised. EPA's failure to address or rebut each and every point in your letters should not be construed, as your letter of October 11, 1990 implies, as EPA's agreement with the facts or conclusions stated by Montrose.

In response to your October 23, 1990 letter to Richard Martyn, two major comments are warranted. First, you state that Montrose has offered "to participate per capita with the other named Respondents." While EPA hopes that the Respondents cooperate in complying with the Order, and while EPA remains ready to assist the Respondents in this task, CERCLA provides for joint and several liability; EPA considers each Respondent responsible for one hundred percent of the work required by the Order. Accordingly, regardless of whether the other Respondents agree to participate, Montrose is required to fully comply with the terms of the Order.

Second, with regard to your claimed willingness to negotiate regarding the Phase I work in the Order, CERCLA 106 Orders are not negotiable documents. Nevertheless, EPA has been willing to meet with the Respondents to this Order as frequently as they have desired and have been willing to discuss the Order and consider amendments to it. In fact, EPA representatives have met with you on three separate occasions regarding the Order and remain available to discuss the Order with you either in person or via telephone. Further, EPA is unwilling to consider Montrose's agreement to comply with only a self-selected portion of the Order (Phase One work) to be adequate. The Order clearly states that the Respondent must inform EPA of its intent to fully comply with the Order. Montrose's conditional, partial intent to comply is therefore in violation of the Order.

In response to your letter of October 16, 1990, as I have indicated previously, EPA is doing everything possible to respond to your Freedom of Information Act request as quickly as possible. As you are aware, EPA is in the process of moving its offices and many of our files and records are packed and in storage. Accordingly, we are anticipating a four to six week delay in responding to Freedom of Information Act requests. However, despite this fact, EPA personnel are in the process of compiling a partial response to your request. With regard to your request for a copy of the administrative record regarding this matter, the National Contingency Plan provides that EPA has sixty (60) days in which to compile an administrative record for an emergency removal. However, if the administrative record is available prior to that date, we will be happy to foward it to you at that time.

Your letter of October 11, 1990, is Montrose's view of what occurred at a meeting between attorneys for Montrose and representatives of EPA. EPA's view is different in a number of respects, including the following:

First, EPA was not present at the July 25, 1990 status conference before Judge Conti. Accordingly, we do not know what was said to the Judge on that date. Second, although EPA did provide Montrose with 24 hours in which to inform EPA of its intent to comply with the Order, EPA agreed to a 48 hour extension of that deadline upon Montrose's request and Montrose never requested a further extension. Third, EPA is somewhat surprised by Montrose's claim that it had no prior notice regarding the work needed to be done at the Site or Montrose's liability. Private litigation, to which Montrose is a party, regarding this Site has been ongoing for over five years. Further, the Levin entities claim to have made all state orders and agreements, including a state order addressing much of the same work addressed in EPA's Order, available to Montrose. Fourth, EPA did assert that the theory set forth in Aceto was one of the theories under which EPA believes Montrose is liable at the Site. However, EPA did not intend to suggest that this was the only theory of liability. Fifth, EPA never received the October 5, 1990 letter referenced.

Finally, with respect to your letter of October 3, 1990, EPA has read and considered each and every item raised in your letter. Nothing in that letter has altered our view that Montrose is jointly and severally liable for all of the contamination discussed in EPA Order 90-22.

EPA wishes to reiterate its willingness to work with the Respondents in an attempt to achieve cooperation among the Respondents regarding the terms of the Order. However, EPA considers each Respondent fully liable for the contamination addressed by the Order and wants to make sure Montrose is aware that EPA expects Montrose to comply with all of the terms of the Order regardless of participation by the other Respondents.

If you have any questions, please to not hesitate to contact me at (415) 744-1311.

Sincerely,

Geoffrey R. Kors

Geoffrey R. Kors

Rwc #91

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 HAWTHORNE STREET
SAN FRANCISCO, CA 94105

OFFICE OF REGIONAL COUNSEL
FACSIMILE COVER SHEET

DATE: 10/16/90

TO: Richard Rauschenbush

SUBJECT:

OFFICE: PHONE #:

FAX #: 619-596-7419 VERIFICATION #:

FROM: EPA (Geoff Kors)

PHONE #: (415) 744 - 1311
[FTS Prefix 744-xxxx]

NUMBER OF PAGES, INCLUDING THIS COVER SHEET:

* *

EQUIPMENT	FAX #	VERIFICATION #
REGIONAL COUNSEL OFFICE (16th Floor)	(415) 744-1041 FTS 744-1041	(415) 744-1080 FTS 744-1080
Regional Counsel and Deputy Regional Counsel	(415) 744-1040 FTS 744-1040	(415) 744-1366 FTS 744-1366
COMMUNICATION CENTER (11th Floor)	(415) 744-1070 FTS 744-1070	(415) 744-2494 FTS 744-2494

* *

5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105

RECEIVED
DEC - 3 1990

Certified Mail: P 347 509 129
Return Receipt Requested

November 27, 1990

Albert C. Perrino, President
Montrose Chemical Corporation of California
830 Post Road East
Westport, Connecticut 06880-5222

Re: Request for Information
United Heckathorn Superfund Site
Richmond, California

Dear Mr. Perrino:

The United States Environmental Protection Agency (EPA) is spending public funds to investigate and take corrective action for the control of actual or threatened releases of hazardous substances at the United Heckathorn Superfund (Site), in Richmond, California. EPA is conducting this investigation to determine the nature and extent of contamination in the area, to assess the effects of contamination on the environment and public health and to identify activities and parties that contributed to contamination in the area. The purpose of this letter is to request information regarding your association with the Site.

The former United Heckathorn facility was located at 402 Wright Avenue in Richmond, California. From approximately 1945 through 1965, R.J. Prentiss, Heckathorn and Company, United Heckathorn, United Chemetrics and Chemwest, (collectively referred to as the "Heckathorn Companies"), ground, formulated and packaged pesticides which included DDT, Dieldrin and BHC at the Site. Currently, the Site is an active marine shipping terminal owned by Levin Enterprises. The Site is contaminated with DDT, Dieldrin, BHC and other chemicals.

EPA believes that Montrose Chemical Corporation ("Montrose") is in possession of information that is relevant to our investigation. Pursuant to the authority of Section 104(e) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. §9604(e), EPA requests that you respond to the Information Request set forth in Attachment A and that you provide copies of all documents your company possesses or has access to regarding the Site or disposal of wastes at the Site.

Federal law requires you to provide the requested information and documents to EPA. Section 104(e)(2) of CERCLA, 42 U.S.C. §9604(e)(2), states that EPA may require:

> Any person who has or may have information relevant to any of the following to furnish, upon reasonable notice, information or documents relating to such matter:
>
> (A) The identification, nature, and quantity of materials which have been or are generated, treated, stored, or disposed of at a vessel or facility or transported to a vessel or facility.
>
> (B) The nature or extent of a release or threatened release of a hazardous substance or pollutant or contaminant at or from a vessel or facility.
>
> (C) Information relating to the ability of a person to pay for or perform a cleanup.

Please note that your compliance with this information request is mandatory. Failure to respond fully and truthfully may result in enforcement action by EPA pursuant to §104(e) of CERCLA, 42 U.S.C. §9604(e). This statutory provision authorizes EPA to seek the imposition of penalties of up to $25,000 per day of noncompliance. Please be further advised that provision of false, fictitious or fraudulent statements or representations may subject you to criminal penalties under 18 U.S.C. §1001. In addition, pursuant to Section 103 of CERCLA, 42 U.S.C. §9603, it is unlawful for any person knowingly to destroy, mutilate, erase, dispose of, conceal, or otherwise render any documents unavailable or unreadable or to falsify certain records which must be retained under that Section.

Your response should include the appropriate name, address, and telephone number of the person within your company or organization to whom EPA should direct future correspondence in regard to this matter.

Referencing responses to information requests which you have received from other federal agencies and/or referring EPA to documents which were produced in response to demands for information in Levin Metals Corporation, et al. vs Parr-Richmond Terminal Company (U.S. Dist. Ct., N.D. Calif., Nos. C-084-6324-SC, C-84-6273-SC, and C-85-4776-SC; and the Superior Court of the State of California, Contra Costa County, No. 255836) does not constitute an acceptable response to this information request. In order to comply with the statutory requirements of this information request you must provide a direct written response to each of the questions posed and you must support each response by providing EPA with copies of all relevant documents.

Your response to this Request for Information must be made in writing, signed by you or a duly authorized official of your company and submitted by certified mail to EPA within thirty (30) calendar days of receipt of this letter. Your response should be directed to:

Colleen Smith, Environmental Scientist
U.S. Environmental Protection Agency, Region IX
75 Hawthorne Street
San Francisco, California 94105.
H-7-4

Please direct any general questions with respect to the Site or this Information Request to Colleen Smith at (415) 744-2380.

Please direct any legal questions to:

Geoffrey Kors
U.S. Environmental Protection Agency, Region IX
Office of Regional Counsel, RC-5
75 Hawthorne Street
San Francisco, California 94105
(415) 744-1311

Thank you for your attention to this matter.

Sincerely,

Jerry Clifford

Jerry Clifford
Deputy Director for Superfund
Hazardous Waste Management Division

Attachments

6

PB81-117491

AMBIENT WATER QUALITY CRITERIA FOR DDT

U.S. Environmental Protection Agency
Washington, DC

Oct 80

U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
NTIS

United States
Environmental Protection
Agency

Office of Water
Regulations and Standards
Criteria and Standards Division
Washington DC 20460

EPA 440/5-80-038
October 1980

PB81-117491

EPA

Ambient Water Quality Criteria for DDT

Single ingestion of 10 mg/kg produces illness in some, but not all, subjects. Smaller doses generally produce no illness. Convulsions and nausea frequently occur in dosages greater than 16 mg/kg. Dosages as high as 285 mg/kg have been taken without fatal result, but such large dosages are usually followed promptly by vomiting, so the amount retained is variable (Hayes, 1963).

Although a number of pathological changes have been noted in experimental animals, the most consistent finding in lifetime feeding studies has been an increase in the size of liver, kidneys and spleen, extensive degenerative changes in the liver and an increased mortality rate. In rats, Laug, et al. (1950) observed hepatic alteration with feedings in diet at 5 ppm DDT. At dose levels of 600 and 800 ppm, significant decreases in weight gain and increased mortality were observed in rats (Fitzhugh and Nelson, 1947). The observation that increased mortality results from doses above 100 ppm DDT in the diet is well established in mice (Walker, et al. 1972).

In contrast to the rodent models, Rhesus monkeys fed diets with up to 200 ppm DDT showed no liver histopathology, no decrease in weight gain or food consumption, or no clinical signs of illness. Several monkeys fed 5,000 ppm in the diet had some weight loss prior to early death due to DDT poisoning (Durham, et al. 1963). In one animal, liver pathology consistent with DDT poisoning in other animals was found.

No clinical or laboratory evidence of injury to man by repeated exposure to DDT has been reported. Volunteers ingesting up to 35 mg/day for 21 months had no alterations in neurological signs, hematocrit, hemoglobin, and white blood cell counts. No changes in cardiovascular status or liver function tests were noted (Hayes, et al. 1971).

Studies of exposed workers by Laws, et al. (1967), Wolfe and Armstrong (1971), and Almeida, et al. (1975) have demonstrated no ill-effects from long-term high levels of exposure, as judged by physical examination and chest X-ray.

Furthermore, the dermal toxicity of DDT in humans is practically nil. A few cases of allergic reaction have been observed, which may be due to the extreme sensitivity of the individual.

Synergism and/or Antagonism

One of the primary concerns about pesticide residues is the possibility that they may act synergistically with other chemicals over a long period to produce cancer. The accumulation and summation of carcinogenic exposure from various sources may present a health problem of great significance.

DDT, a strong inducer in the mixed function oxidase system, potentially could enhance the biological effects of other chemicals by activation or diminish their activities through detoxification mechanisms. Weisburger and Weisburger (1968) were able to enhance the incidence of hepatomas in rats caused by N-fluorenacetamide (2-AAF) by co-administration of DDT. They had previously shown that 2-AAF is metabolized by a mixed function oxidase system (MFO) to the hydroxy intermediate which is carcinogenic. By stimulating liver metabolism with 10 mg/day DDT which, by itself, causes no hepatomas, the percentage of animals bearing tumors from a dose of

7

Contaminated Dredged Material

Control, Treatment and Disposal Practices

M. John Cullinane et al
Willis E. Pequegnat

POLLUTION TECHNOLOGY REVIEW No. 179

ndc

CONTAMINATED DREDGED MATERIAL

Control, Treatment and Disposal Practices

by

M. John Cullinane, Daniel E. Averett, Richard A. Shafer
James W. Male, Clifford L. Truitt, Mark R. Bradbury

U.S. Army Waterways Experiment Station
Vicksburg, Mississippi

Willis E. Pequegnat

La Jolla, California

NOYES DATA CORPORATION
Park Ridge, New Jersey, U.S.A.

report (Phillips et al. 1985) reviewed most of the methods and techniques available for controlling the impacts of dredging and disposing of contaminated sediment. Chapters 2, 3, 4, 5, and 6 of this report will rely heavily on the process descriptions for the various methods and alternatives discussed in the Commencement Bay report. The "Decisionmaking Framework" (Lee et al. 1985) addresses the question: Are restrictions necessary for disposal of contaminated dredged material? However, it does not identify testing required to address design of a disposal site or selection of necessary control or treatment options. The "Decisionmaking Framework" will be used in Chapter 9 to develop a strategy for selection of control/treatment options.

Nature of Contaminated Sediment

Sediment deposited on the bottom of streams, lakes, and coastal waters varies in physical and chemical composition. Because many water contaminants are attracted by and become attached to sediment particles, contaminant concentrations in sediment are generally much greater than in water. Drainage basins with concentrated urban, industrial, or agricultural sources often contribute significantly to downstream sediment contamination. Such is the case with Puget Sound.

The environmental impact of sediments depends on the amount of contaminant present and the mobility of the contaminant into environmental pathways by biological or hydrodynamic processes. The chemistry of contaminants in sediment is controlled primarily by the physicochemical conditions under which the sediment exists. Fine-grained sediment is typically anoxic, reduced, and near neutral in pH. How disposal environments affect these chemical characteristics is an important consideration in the selection of disposal options. If sediment is disposed in an aquatic environment, sediment chemistry may not change. However, transfer of the sediment to a dryer environment, such as an upland disposal site, may change the chemistry to an oxic and lower pH condition more favorable to the release of contaminants (Lee et al. 1985).

Biological and physical processes may also affect the release of contaminants at a disposal site. Different contaminants and sediments with different properties do not always respond similarly to an altered biological or physicochemical condition. This requires testing on an individual basis for site-specific sediment contamination problems (Gambrell et al. 1978).

Puget Sound dredging projects may be conducted to maintain navigation channels, to create new harbors and port facilities, or to remove contaminated sediment (remedial actions). Projects whose purpose is remedial action will by definition contain contaminants that require special considerations during disposal. Maintenance or new work dredging may involve sediment with various degrees of contamination. This study considers disposal options for contaminated sediment from all three types of projects.

Levels of Control/Treatment

The "Management Strategy" for disposal of dredged material (Francingues et al. 1985) discussed the two initial alternatives available for disposal of contaminated dredged material: open-water disposal and confined disposal. If the testing protocols identified in the management strategy show that conventional open-water, nearshore, or upland disposal will have an adverse impact on the environment, then open-water disposal with restrictions would be considered first followed by confined disposal with restrictions. This study begins where the management strategy ends. It discusses available options and decision points necessary to determine if design of a particular alternative is feasible and to select the best alternative(s) or combination of alternatives.

When dredging contaminated material, two other levels of control should be considered. Control of sediment resuspension and contaminant release during dredging (at the dredge head) and controls to prevent release of contaminated material during transport of dredged material will be discussed. In addition, the confined disposal options for nearshore and for upland sites will be considered as two separate levels although many of the control/treatment measures for the two are the same. This yields five levels of control/treatment to be considered by this study:

- Controls during dredging
- Controls during dredged material transport

2. Contaminant Control During Dredging Operations

Background

During dredging operations all dredge plants, to differing degrees, disturb bottom sediment, creating a plume of suspended solids around the dredging operation. The suspended solids plume can form relatively low concentrations in the upper water column, high concentrations near the bottom, or both depending on the type of soil and the amount of energy introduced into the sediment by the dredge. The material suspended in the water column is often referred to as turbidity; the dense near-bottom suspensions are commonly called fluid mud or fluff. In the most strict sense, turbidity describes a complex relationship of factors that affect the optical properties of the water column. Suspended solids concentrations are best presented in gravimetric units such as milligrams or grams per liter indicating the weight of dry solids in a volume (liter) of sample.

Due to aesthetic and/or biological reasons, it may be generally advantageous to keep resuspension to a minimum. Limitations may be placed on levels of suspended solids when even normal dredging operations occur around public areas or coral reefs or during certain periods in the life cycle of a specific marine species (Lunz, Clark, and Fredette 1984). However, the major problems from suspended solids occur while dredging contaminated sediment. Contaminated sediment may release contaminants into the water column through resuspension of the sediment solids, dispersal of interstitial water, or desorption from the resuspended solids. Once resuspended, fine-grained sediment (clay and silt) tend to remain in the water column longer due to their low settling velocity. These fine-grained sediment fractions also have the highest affinity for several classes of contaminants, such as organics and heavy metals which have made their way into the waterway. Fulk, Gruber, and Wullschleger (1975) showed that, for these classes of contaminants, the amounts that are dissolved or desorbed are negligible and basically all contamination transferred to the water column is due to resuspension of solids. Clearly, the control of sediment resuspension during dredging will reduce the potential for release of contaminants and/or their spread to other previously uncontaminated areas.

11. Conclusions and Recommendations

Conclusions

Dredging and dredged material disposal have been extensively evaluated and researched in recent years, and the literature is abundant with reports of laboratory and field studies, literature reviews, and concepts for handling dredging and disposal operations. Most of this literature deals with relatively clean sediment. Disposal of contaminated sediment has received less attention, but recently has come to the forefront of consideration and study because of problems and questions that have surfaced in protecting the environment from the effects of contaminated dredged material disposal and in selecting, engineering, and operating disposal sites for contaminated dredged material. Other concerns have arisen from controlling contaminants that may be released at the dredging site or that may be released during transport from the dredging site to the disposal area.

Management, control, and treatment technologies have been oriented to the control of suspended sediment. While control of suspended sediment must be an integral part of any strategy for control of contaminants, control/treatment of contaminated dredged material generally must go beyond control of suspended sediment.

Long-term release of contaminants via various pathways from disposal/ sites cannot be ignored. Techniques for predicting these releases are under development and more information is needed to assess environmental effects and the need for controls and to provide design data for treatment processes.

Control technologies are available and have been proposed for containment and/or treatment of sediment and site waters expected at a dredged material disposal site. Beyond removal of suspended sediment from disposal area overflow, few technologies have been demonstrated for contaminated dredged material. Strategies for implementation of controls for a dredging scenario have not been adequately developed.

Design procedures for site water treatment technologies at upland and nearshore disposal sites are available and proven. Bench-scale tests for determining design parameters for treatment of site waters and leachate are essentially the same as those in the water treatment and wastewater treatment industry and can be applied to treatment processes at disposal areas.

general conclusion. Using the cesium:potassium ratio to rank marine organisms according to trophic levels, Young and Mearns (1979) measured Cd levels in the biota of the Salton Sea and two marine food webs along the coast of California. The Cd concentrations did not increase with trophic level in any of these food webs, which involved fishes from levels of II through V and invertebrates from II through IV.

Other Metals

Since there is no evidence that other metals, such as lead and arsenic, do biomagnify, they will not be discussed here.

Movements of Some Synthetic Organic Compounds in Marine Food Webs

There are some organic compounds that have significant potential for biomagnification. Kay (1984) cites PCBs, benzo(a)pyrene, the naphthalenes and possibly dieldrin, endrin, kepone, and mirex. As a result of these possibilities the fate of each of these will be discussed below as they relate to dredged material and marine food webs.

Polychlorinated Biphenyls (PCBs) and Chlorinated Pesticides

PCBs are widely distributed in inland and coastal sediments and have been found in deep ocean sediments far from shore (Burks and Engler 1978). Although the manufacture, use, and disposal of many of these compounds have been restricted by Federal action, they are very persistent and will be found in the environment for years to come. Moreover, their manufacture and use has not been curtailed in all countries, hence their levels in the ocean may well continue to rise.

All chlorinated hydrocarbons are strongly bound to the solid phase in typical soil and sediment-water systems (Burks and Engler 1978). In field studies designed to determine the potential for long-term release at subaqueous disposal sites, no such release has been found (Brannon et al. 1978).

8

NEWS & ANALYSIS

ARTICLES

Managing Contaminated Sediments in Aquatic Environments: Identification, Regulation, and Remediation

by W. Andrew Marcus

Editors' Summary: The contamination of sediments in aquatic environments poses a direct threat to water quality, bottom-dwelling organisms, and animals feeding on those organisms. In recognition of the pervasive nature of this problem, several state and federal agencies are attempting to fashion guidelines for identifying, regulating, and cleaning up polluted sediments. This Article summarizes those efforts in light of the key regulatory and scientific dilemmas faced by agencies attempting to manage such sediments. Specifically, it provides a brief synopsis of the history and extent of contamination problems in the United States and the need for management strategies. A major problem in developing these management strategies has been defining what constitutes a "clean" or a "polluted" sediment. The Article summarizes historical and contemporary approaches to identifying polluted sediments and discusses hydrologic, biochemical, and regulatory problems involved with each methodology. It then examines the legal bases for federal management of aquatic sediments and what practitioners need to know when navigating current hazardous waste and water issues. The Article concludes with a discussion of the techniques for mitigating contamination in aquatic sediments and the difficulties practitioners and regulatory personnel must address when implementing these techniques.

Problems associated with the contamination of aquatic sediments have been recognized for at least 60 years,[1] although widespread concern did not surface until the late 1970s. Early efforts to reduce pollution in aquatic systems focused on reducing point-source discharges to surface waters, which deflected attention from the threat posed by already polluted sediments. Public and scientific pressure to regulate sediments erupted after well publicized incidents of sediment damage to fisheries and wildlife, such as polychlorinated biphenyl (PCB) contamination in the Hudson River[2] and a wide variety of pollutants in Puget Sound[3] and Great Lakes[4] sediments. This heightened concern has resulted in research documenting the processes contributing to sediment pollution, the extent of this pollution, and problems associated with sediment contamination.[5]

W. Andrew Marcus is an Assistant Professor in the Department of Geography, University of Maryland at College Park. He received his Ph.D. in geography from the University of Colorado, his M.A. in geography from Arizona State University, and his B.S. in geology from Stanford University. His research has focused on water policy and human impacts on runoff, erosion, and contaminant transport in sediments. Dr. Marcus teaches classes on environmental systems, geomorphology, hydrology, field research techniques, and water resources policy. The author wishes to thank Mr. Chris Zarba for his critical review and comments.

1. In perhaps the first work on problems associated with contaminated sediments, K. Carpenter demonstrated in the 1920s that the mobilization of mine tailings and debris during floods was responsible for fish kills in the lead mining district of Wales. *See* Carpenter, *A Study of the Fauna of Rivers Polluted by Lead Mining in the Aberystwyth District of Cardiganshire,* 11 ANNALS OF APPLIED BIOLOGY 1 (1924).
2. A good overview of PCB contamination and cleanup efforts in the Hudson River is provided by Carcich & Tofflemire, *Distribution and Concentration of PCB in the Hudson River and Associated Management Problems,* 7 ENVTL. INT'L 73 (1982).
3. Summarized in U.S. ARMY CORPS OF ENGINEERS/WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES, FINAL ENVIRONMENTAL IMPACT STATEMENT—UNCONFINED OPEN-WATER DISPOSAL SITES FOR DREDGED MATERIAL, PHASE 1 (CENTRAL PUGET SOUND, 1988) [hereafter CORPS/WASH. ST. ENVIRONMENTAL IMPACT STATEMENT].
4. An excellent table summarizing the wide variety and levels of sediment contamination in the Great Lakes region is found in INTERNATIONAL JOINT COMMISSION, PROCEDURES FOR THE ASSESSMENT OF CONTAMINATED SEDIMENT PROBLEMS IN THE GREAT LAKES: A REPORT TO THE GREAT LAKES WATER QUALITY BOARD BY THE SEDIMENT SUBCOMMITTEE AND ITS ASSESSMENT WORK GROUP 14 (Windsor, Ontario, 1988).
5. Although it is a recent scientific field, the research pertaining to contamination of aquatic sediments is voluminous. A good and relatively nontechnical overview of processes controlling sediment pollution and environmental consequences is supplied by R. ALLAN, THE ROLE OF PARTICULATE MATTER IN THE FATE OF CONTAMINANTS IN AQUATIC ECOSYSTEMS (Scientific Series No. 142, Inland Waters Directorate, Canada Centre for Inland Waters, 1986).

Contamination of Aquatic Sediments and Environmental Consequences

Risk-posing aquatic sediments are generated in three ways. In the most obvious pathway, contaminated sediments are created directly, as with sewage sludges or fly ash from power plants. In another pathway, solids with naturally high concentrations of a contaminant are altered so that the pollutant can be more easily released to the environment. This most commonly occurs in mining operations, where heavy metal-bearing rocks are milled into very fine particles for extraction purposes.[6] Only a portion of the total metal content is removed in the refining process, which leaves substantial quantities of metal in the fine grained sediments. When these sediments are disposed of, usually in tailings piles, they can introduce metal contamination to points far from the original source through groundwater percolation, windblown dispersion, and erosion and transport by streams.

The third and perhaps most prevalent pathway of sediment contamination is via the sorption of dissolved substances onto sediment surfaces.[7] A large portion (often the majority) of organic and inorganic pollutants in aqueous solution will migrate to sediment surfaces, particularly if the sediments have a large clay component or a high organic content. Processes of atmospheric deposition and water-borne contamination can thus pollute sediments that are tens and even hundreds of kilometers from the original source.

Once contaminated, aquatic sediments pose a particularly pernicious form of pollution, acting as a long-term reservoir that can introduce toxins to the environment far from the original source and long after discharge activity has shut down. Pollutants in aquatic sediments cause environmental damage by releasing toxins to surrounding waters, directly contaminating flora and fauna that live within and ingest the sediments, and by introducing toxins into the food chain, which are then transferred up the trophic ladder to higher organisms, including humans.

The release of sediment-bound toxins into the water column is particularly notable during storms, when increased flows and turbulence place bottom sediments in suspension, promoting rapid chemical fluxes between sediments and the surrounding water. The introduction of these slugs of contaminated sediments into the water column can have immediate effects, leading to significant fish kills.[8] Equally damaging, but less obvious, is the long-term release of contaminants to interstitial waters and the overlying water column.

Major factors that can mobilize substances from sediments and into surrounding waters include changes in salinity and oxygen content of the water, acidity, introduction of organic complexing agents, and microbial activity.[9] The variability in these factors creates a complex coupling of the aqueous and sedimentary environments, which can produce counter-intuitive and frustrating results for water quality managers. Thus, one cannot assume that high concentrations of a pollutant in sediments are necessarily linked to high pollutant concentrations in the nearby waters. In Boulder Creek, Arizona, for example, concentrations of copper, lead, and cadmium make up almost two percent by weight of the bottom sediments near an old mine, but alkaline stream conditions prevent large quantities of toxins from entering the water and the stream supports a robust aquatic community a short distance below the mine.[10] In a more disheartening example, a 1983 algal bloom in the Potomac River was partially linked to improved sewage treatment, with summer nitrification of sewage discharge increasing the water alkalinity and promoting large releases of phosphorous from bottom sediments.[11]

The biological effects of chemicals in sediments are even more difficult to define than the relation between sediments and water quality. Although damage to aquatic organisms from sediment contamination has been well documented in numerous settings, the ability to predict potential damages is poor.[12] Under natural environmental conditions, a host of factors other than the concentration of a given contaminant in sediments can influence the viability of an organism. These factors include the chemical form of the contaminant; synergistic effects when multiple contaminants are present; the nature of the individual organism and specie; community structure; physical disturbances (e.g., boat traffic and associated turbulence); water quality; and related environmental conditions, such as temperature, salinity, and pH.

Damages to water quality and aquatic organisms resulting from contaminated sediments have prompted a number of agencies to take regulatory and remedial actions at specific sites.[13] Preliminary work by the Environmental

6. The process of metal contamination of sediments and the aquatic environment is comprehensively treated in two books that constitute the basic reference texts for researchers examining heavy metal pollution. *See* U. FORSTNER & G. WITTMANN, METAL POLLUTION IN THE AQUATIC ENVIRONMENT (2d ed. 1983); W. SALOMONS & U. FORSTNER, METALS IN THE HYDROCYCLE (1984). An abbreviated and more accessible summary for the nonscientist is in J. ELDER, METAL BIOGEOCHEMISTRY IN SURFACE-WATER SYSTEMS: A REVIEW OF PRINCIPLES AND CONCEPTS (U.S. Geological Survey Circular 1013, 1988).

7. The biogeochemical processes controlling contaminant transfer to and from sediments are complex, often difficult to study, and frequently differ from site to site. Even basic references tend to be difficult for the nonchemist to read. Appropriate starting points for persons with introductory college-level chemistry include FORSTNER & WITTMANN, *supra* note 6, at chap. E, and SALOMONS & FORSTNER, *supra* note 6, at chap. 2 for a discussion of metal-sediment interactions. *See also* E. THURMAN, ORGANIC GEOCHEMISTRY OF NATURAL WATERS, chap. 11 (1985) (presentation of organic-sediment geochemical processes).

8. Carpenter, *supra* note 1; *see also* Williams, Joyce & Monk, *Stream-Velocity Effects on Heavy Metal Concentrations*, 65 AM. WATER WORKS CONTROL A. 275 (1973).

9. FORSTNER & WITTMANN, *supra* note 6, at 247-70; THURMAN, *supra* note 7; *see also* A. HOROWITZ, A PRIMER ON TRACE METAL-SEDIMENT CHEMISTRY (U.S. Geological Survey Water-Supply Paper 2277, 1985).

10. Rampe & Runnells, *Contamination of Water and Sediment in a Desert Stream by Metals From an Abandoned Gold Mine and Mill, Eureka District, Arizona, U.S.A.*, 4 APPLIED GEOCHEMISTRY 445 (1989).

11. *See* METROPOLITAN WASHINGTON COUNCIL OF GOVERNMENTS, POTOMAC RIVER WATER QUALITY 1982-1986, TRENDS AND ISSUES IN THE METROPOLITAN WASHINGTON AREA (1989).

12. A good introduction to the breadth of scientific literature available regarding the effects of contaminated sediments on biological systems is provided in chapters 12 through 18 of K. DICKSON, FATE AND EFFECTS OF SEDIMENT-BOUND CHEMICALS IN AQUATIC SYSTEMS (1987) [hereafter DICKSON]; *see also* LUOMA, BIOAVAILABILITY OF SEDIMENT-BOUND METALS, THE ROLE OF SEDIMENTS IN THE CHEMISTRY OF AQUATIC SYSTEMS—PROCEEDINGS OF THE SEDIMENT CHEMISTRY WORKSHOP, FEBRUARY 8-12, 1982 (U.S. Geological Survey Circular 969, 1988).

13. *See, e.g.*, Carcich & Tofflemire, *supra* note 2; CORPS/WASH. ST. ENVIRONMENTAL IMPACT STATEMENT, *supra* note 3; and INTERNATIONAL

Protection Agency (EPA) and the consulting firm Battelle strongly suggests, however, that sediment pollution is not limited to these sites but is present nationwide in both fresh and marine waters.[14] Despite using a data set with geographic gaps, the study discovered that metal concentrations at 293 sites across the United States exceeded tentative sediment standards by a factor of three. Pesticides exceeded sediment standards by a factor of three at 453 sites; and PCBs, polynuclear aromatic hydrocarbons (PAHs), cyanide, and phthalates exceeded these tentative standards by a factor of three at 134 locations. Pesticide hot spots tended to be uniformly distributed across the country, while metal and non-pesticide organic pollutants in sediments were generally clustered near industrial areas of the Northeast, Great Lakes, and West Coast. These results are even more disturbing because the data did not include floodplain or offshore environments, where concentrations may be orders of magnitude higher due to the high clay component of the sediments.

Damage to natural resources resulting from contamination of aquatic sediments has been well documented. The ongoing debate within environmental, industrial, and regulatory communities no longer centers on whether sediment contamination should be regulated, but rather on how to best regulate sediment pollution.

Identifying Polluted Sediments: The First Step in Regulation

The starting point in the debate over regulating sediment contamination has consistently revolved around a simple question: how can one distinguish between a clean and a polluted sediment? The answer will largely define the scope of the contaminant problem, the responsible parties, the remedial cleanup efforts needed, and the costs of cleanup. Given the potential for the answer to force costly investments by the government and private sectors, it is not surprising that the approaches to solving this issue have raised a contentious debate within the scientific and regulatory communities.[15] In broad terms, several major issues have dominated the debate over how to define contaminated sediments, including: (1) what medium or media (i.e., sediments, water, or organic matter) should be tested to determine if sediments are polluted; (2) should the tests provide a universal standard applicable at any site or should the tests be based on a set of site-specific parameters; and (3) should the standards be set up for individual chemicals or should testing procedures allow for evaluation of multi-chemical mixtures?

The question of which medium or media to use is crucial, since the answer in large part will determine whether the test must be site specific and whether the test must be used for individual chemicals or chemical mixtures. The many media that can be used to define contamination thresholds complicate the debate. Sediment pollution can be defined as a function of the pollutant concentrations in sediments, the pollutant concentrations in interstitial waters, the pollutant concentrations in benthic flora and fauna, how the sediments impact biological populations, or some combination of the above. Concentrations of pollutants in sediments can be used to define contaminant thresholds by setting arbitrary levels that concentrations may not exceed, or by using partition coefficients to define levels where contaminant concentrations in sediments adversely affect water quality. Concentrations in interstitial waters (i.e., the water between sediment particles) can be measured to determine if sediments are polluting surrounding waters. Measuring contaminant concentrations in body tissues of biota provides a direct measure of the transfer of pollutants into the food chain. Finally, differences between populations at different sites can be used to determine sediment impacts.

The Reference Approach

The earliest sediment criteria were based on contaminant concentrations in natural, background, or reference sediments. These reference levels were used as a baseline to establish numerical criteria that were not to be exceeded in sediments. Early efforts in the Great Lakes[16] and Puget Sound[17] used the reference technique to set limits on contaminant levels in sediments for open-water dredge disposal. Although simple to use, relatively inexpensive to implement, and useful as a stopgap measure, this technique has major scientific and regulatory flaws. Criteria defined using the reference approach are site-specific and subject to dispute, being largely dependent on which sites are chosen to represent the background or reference condi-

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JOINT COMMISSION, *supra* note 4, for summaries of efforts in the Hudson River, Puget Sound, and Great Lakes, respectively; *see also* WATER QUALITY TASK GROUP, DRAFT CHESAPEAKE BAY BASINWIDE TOXICS REDUCTION STRATEGY (U.S. Environmental Protection Agency Chesapeake Bay Program, 1989), for recent proposed efforts in the Chesapeake Bay region.

14. H. BOLTON, R. BRETELER, B. VIGON, J. SCANLON & S. CLARK, NATIONAL PERSPECTIVE ON SEDIMENT QUALITY (U.S. Environmental Protection Agency, Office of Water Regulations and Standards, EPA Contract No. 68-01-6986, 1985).

15. Much of the following discussion is condensed and summarized from more in-depth explanations of the techniques for identifying contaminated sediments and the debate over these methods. *See* Chapman, *Establishing Sediment Criteria for Chemicals—Regulatory Perspective*, in DICKSON *supra* note 12, at 355; Chapman, *Current Approaches to Developing Sediment Quality Criteria*, 8 ENVTL. TOXICOLOGY & CHEMISTRY 589 (1989) [hereafter Chapman (1989)]; 1 TETRA TECH, INC., DEVELOPMENT OF SEDIMENT QUALITY VALUES FOR PUGET SOUND (1986). Proceedings of an EPA workshop that initiated much of EPA's effort to develop sediment criteria are contained in JRB ASSOCIATES, BACKGROUND AND REVIEW DOCUMENT OF THE DEVELOPMENT OF SEDIMENT CRITERIA (U.S. Environmental Protection Agency Contract Number 68-01-6388, McLean, Virginia, 1984). The earliest work on managing contaminated sediments occurred in the 1970s and was spearheaded by the Corps in response to the disposal of dredge materials. The legislative history, legal requirements, evaluative procedures, and problems with the procedures used by the Corps prior to 1980 are well summarized in 1 CONTAMINANTS AND SEDIMENTS, ch. 27; ENGLER, PREDICTION OF POLLUTION POTENTIAL THROUGH GEOCHEMICAL AND BIOLOGICAL PROCEDURES: DEVELOPMENT OF REGULATION GUIDELINES AND CRITERIA FOR THE DISCHARGE OF DREDGED AND FILL MATERIAL (R. Baker ed.) (1980).

16. The first guidelines for the disposal of sediments are often called the Jensen criteria and were promulgated in 1971 by the Federal Water Quality Administration (predecessor of EPA), in response to contaminant problems in the Great Lakes. *See* R. BOWDEN, GUIDELINES FOR THE POLLUTIONAL CLASSIFICATION OF GREAT LAKES SEDIMENTS (U.S. Environmental Protection Agency Region V, 1977). Incredibly, many of the early Jensen criteria set contaminant levels that were lower than average global crustal abundance for the substance. Barium concentrations, for example, of 75 mg/kg in sediments were classified as heavily polluted, when the average crustal abundance of barium is 200 mg/kg. *See* Engler, *supra* note 15, at 147.

17. *See* TETRA TECH, INC., *supra* note 15, at 5.

tions. In the case of synthetic substances (e.g., PCBs), it is impossible to define natural concentrations, and criteria must be based on existing concentrations in already polluted areas, without clear evidence of whether the criteria sufficiently protect aquatic populations and water quality.[18] The criteria also do not account for chemical mixtures, the chemical form of the contaminant, or other factors that affect bioavailability and sediment impacts.

The Equilibrium Partitioning Approach

A more sophisticated technique based on measuring the contaminant levels in sediments is the equilibrium partitioning approach.[19] This approach assumes that during unchanging (i.e., equilibrium) chemical conditions, the ratio (i.e., the partitioning) of contaminant concentrations in bed sediments and interstitial waters remains constant if one corrects for such factors as organic content. Using this technique, one can estimate sediment impacts on water quality by multiplying the contaminant concentration in sediments by the partitioning coefficient. If the resultant value violates existing water quality standards, the sediment is considered polluted. EPA's Criteria and Standards Division has used this technique to develop interim sediment criteria for nonpolar hydrophobic organic compounds (e.g., DDT, dieldrin, heptachlor, lindane, and PCB)[20] and is presently modifying the approach for establishing criteria for heavy metals and polar organics.[21]

A major advantage of the partitioning approach is that it can theoretically account for site-specific factors, so it can be used by regulators on a nationwide basis. Thus, regulators can avoid the extensive on-site testing that most other techniques require. The partitioning approach also takes advantage of existing water quality criteria that have a well established toxicological basis. As with water quality criteria, the equilibrum partitioning approach cannot, however, take into account the effects of chemical mixtures or the potential effects of chemicals for which no water quality criteria exist. The equilibrium approach is also limited by the two major assumptions on which it is based. First, that the system is in chemical equilibrium. Second, that the biota are primarily affected by sediment contamination of the surrounding water, rather than by direct contact with and ingestion of the sediments, or by food chain enrichment. Variations in the sediment/water ratio, concentrations of dissolved organic matter, and techniques for determining the partitioning coefficient can also generate a wide range of partitioning coefficients for a given substance.[22] EPA's Scientific Advisory Board has recommended additional research to validate the technique before it receives widespread application.[23]

In the past, the effort to develop partitioning-based numerical sediment criteria has been criticized on the grounds that a comprehensive national inventory of contaminated sediments had not been completed and EPA had failed to demonstrate a need for criteria.[24] This argument creates a "catch-22": the inventory is necessary to develop the criteria, but no inventory can be completed until criteria exist to define contaminated and clean sediments. EPA has proceeded to assert that numerical criteria must first be developed in order to inventory the extent of the problem.

The Interstitial Water Approach

An obvious way to avoid the assumption of equilibrium partitioning among sediments, waters, and associated chemistry problems is to sample the interstitial waters directly to determine if they violate existing water quality criteria. Although appealing at first glance, and offering the same advantages as the equilibrum partitioning technique, this approach has problems that may prove fatal to its future use. Like the equilibrum partitioning approach, the water quality approach does not account for contamination resulting from direct contact with the sediments, food chain enrichment, effects of chemical mixtures, or the impacts of chemicals for which water quality criteria do not exist. It also cannot be applied in intermittently dry and wet areas, such as floodplains, even though these areas are often major sources of contaminated sediments in aquatic systems.[25] In addition, and perhaps most damaging, the accurate and consistent measurement of contaminant levels in interstitial waters is difficult.[26] The invasive act of sampling often alters pore water concentrations, thus providing an inaccurate portrait of interstitial water concentrations. Extremely small colloidal materials and organic particles in the water samples are also difficult to remove on a consistent basis, which can lead to substantially different analytical results depending on which lab does the testing.[27]

Bioassay Approaches

☐ *The Sediment-Biota Technique*. Ultimately, the goal of managing sediments is to minimize damage to aquatic organisms and humans. Assessing the health of aquatic organisms provides an obvious avenue for determining if

18. PCBs are the only substance for which a legislative action level is set. Under TSCA, any sediments with PCB concentrations of 50 ug/g (micrograms per gram) or greater are classified as hazardous waste. Similarly, under RCRA, any sediment with contaminant concentrations in excess of 100 times established safe drinking water standards is considered hazardous. None of these criteria has a scientific basis.

19. *See* Pavlou, *The Use of the Equilibrium Partitioning Approach in Determining Safe Levels of Contaminants in Marine Sediments*, in DICKSON, *supra* note 12, at 388; *see also* JRB ASSOCIATES, *supra* note 15; Shea, *Developing National Sediment Criteria*, 388 ENVTL. SCI. & TECH. 22 (1988).

20. U.S. ENVIRONMENTAL PROTECTION AGENCY, INTERIM SEDIMENT CRITERIA VALUES FOR NONPOLAR HYDROPHOBIC ORGANIC CONTAMINANTS (Office of Water Regulations and Standards, Criteria and Standards Division, 1988).

21. EPA's ongoing effort to develop sediment partitioning-based criteria is best summarized in U.S. ENVIRONMENTAL PROTECTION AGENCY, BRIEFING REPORT TO THE EPA SCIENCE ADVISORY BOARD ON THE EQUILIBRIUM PARTITIONING APPROACH TO GENERATING SEDIMENT QUALITY CRITERIA (Office of Water Regulations and Standards, Criteria and Standards, 1989).

22. TETRA TECH, INC., *supra* note 15, at 17.

23. SEDIMENT CRITERIA SUBCOMMITTEE, EVALUATION OF THE EQUILIBRIUM PARTITIONING (EQP) APPROACH FOR ASSESSING SEDIMENT QUALITY (U.S. Environmental Protection Agency, Scientific Advisory Board, SAB-EPEC-90-006, 1990).

24. *See* Lyman, *Establishing Sediment Criteria for Chemicals—Industrial Perspective*, in DICKSON, *supra* note 12, at 378.

25. *See, e.g.*, Marcus, *Regulating Contaminated Sediments in Aquatic Environments: A Hydrologic Perspective*, 13 ENVTL. MGMT. 703 (1989).

26. *See, e.g.*, Fanning & Pilson, *Interstitial Silica and pH in Marine Sediments: Some Effects of Sampling Procedures*, 173 SCI. 1228 (1971).

27. TETRA TECH, INC., *supra* note 15, at 11.

sediments are contaminated. One variation on this organism-based approach is the sediment-biota equilibrium partitioning technique, which compares chemical levels in sediments and biota to determine how much of the contaminant load becomes part of an organism's body burden. This approach is appealing because it can be used to set sediment criteria using existing Food and Drug Administration (FDA) guidelines for human consumption or water quality criteria combined with chemical modeling. The sediment-biota technique, however, is limited to evaluating single chemicals, substances for which FDA or water quality criteria exist, and non-water-soluble organics. The assumption of equilibrium is also particularly difficult to prove in living organisms. Finally, it is not clear that FDA standards developed to protect human health effectively protect the health of aquatic organisms.

☐ *The Sediment-Bioassay Approach.* Another biological effects-based technique for identifying contaminated sediments is the sediment-bioassay approach. This method is more comprehensive than the biota partitioning approach, because it delineates polluted sediments on the basis of mortality, sublethal effects, and bioconcentration within aquatic organisms. The bioassay technique can be used in the laboratory with spiked sediments to determine dose-response relations for specific chemicals, or with sediments collected in the field to identify the effects of a complex chemical mixture. The sediment-bioassay technique is based on the same methods used to develop water quality criteria and thus has clear scientific and legal precedents.[28] It is also the technique that has been used in the past by EPA and the Army Corps of Engineers (the Corps) to evaluate dredge materials for ocean disposal.[29] Widespread application of this approach is limited, however, by methodological considerations. Standard sediment-bioassay methods do not exist and an enormous effort would be required to develop standard methods for a wide variety of organisms with different feeding habits in different habitats. The field bioassay test also does not indicate the relative effects of different chemicals within the sediments mixture, which makes it difficult to determine appropriate mitigation techniques and allocate liability.

☐ *The Screening-Level Concentration Approach.* The screening level concentration (SLC) approach uses contaminant concentrations and data on species' presence at multiple sites to establish criteria intended to provide protection for 95 percent of the sediment-dwelling species.[30] The SLC approach can be used at any site for any substance, deals well with chemical mixtures, and is consistent with EPA's water quality goal of protecting 95 percent of aquatic organisms. Regulators, however, have shied away from the SLC approach for a number of reasons.[31] The SLC can be very costly to implement, requiring extensive sampling of both sediments and a variety of species at many sites. The site and species selection process can also bias the results and produce very high or low SLCs. Because the SLC approach is based on field sampling, it cannot control for effects of such environmental variables as temperature, salinity, and pH, which can control species presence independent of any contaminant effects. Furthermore, there is a risk that the presence or absence of species at some or all of the sites is controlled by an unmonitored contaminant so that the SLC values established for monitored substances at those sites are meaningless. Like the bioassay approach, the SLC method does not distinguish between the effects of individual chemicals within the sediments, which complicates attempts to set SLCs for specific chemicals. Despite these limitations, the SLC approach provides a mechanism for establishing no-effect levels and has been used to suggest interim criteria for eight organic contaminants.[32]

Combination Approaches

Other widely reviewed approaches combine features from the previously discussed methods. The sediment quality triad (SQT) approach[33] and the apparent effects threshold (AET) method[34] are very similar, requiring documentation of sediment chemistry at a number of field sites, bioassays using field and reference sediments, and a study of indicators of the health of the benthic community at different sites (e.g., community structure or histopathological abnormalities, such as liver lesions in bottom-feeding fish). The AET approach evaluates these factors independently to generate criteria below which effects on biota are essentially nonexistent.[35] The SQT technique combines the data

28. Chapman (1989), *supra* note 15.

29. U.S. Environmental Protection Agency/U.S. Army Corps of Engineers, Ecological Evaluation of Proposed Discharge of Dredged Material Into Ocean Waters: Implementation Manual for Section 103 of Public Law 92-532 (Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, 1977).

30. The SLC is determined from the sampling of contaminant concentrations in sediments and numerous benthic species at multiple locations. A species screening level concentration (SSLC) is defined for each species as being the pollutant concentration above which 90 percent of that species is found. For example, if a species is present at one site with a pollutant concentration of 110 parts per million and at nine other sites with higher concentrations, 90 percent of the specie's occurrences are found at concentrations higher than 110 ppm and 110 ppm is the SSLC. The SLC is defined as the contaminant concentration above which 95 percent of the SSLCs are found. For example, if the SSLC for one specie at a site is 20 ppm and the SSLCs for 19 other species range between 40 ppm and higher, the SLC is 40 ppm, because 19 of the 20 SSLCs (i.e., 95 percent of the SLCCs) occur at concentrations higher than 40 ppm. Setting the sediment standard in this manner creates a criteria that protects 95 percent of the species. *See* Tetra Tech, Inc., *supra* note 15, at 22; *see also* Neff et al., *An Evaluation of Screening Level Concentration Approach to Derivation of Sediment Quality Criteria for Freshwater and Saltwater Ecosystems*, in 10 Aquatic Toxicology and Hazard Assessment 115 (American Society for Testing and Materials STP 971) (W. Adams, G. Chapman & W. Landis eds., 1987).

31. *See* Chapman (1989), *supra* note 15; Tetra Tech, Inc., *supra* note 15, at 25.

32. SLCs for PCBs, DDT, pyrene, benzo(a)pyrene, naphthalene, fluoranthene, chrysene, and benzo(a)anthracene are discussed in Neff et al., *supra* note 30.

33. Chapman, *Sediment Quality Criteria From the Sediment Quality Triad: An Example*, 5 Envtl. Toxicology & Chemistry 957 (1986); *see also* Chapman & Long, *A Sediment Quality Triad: Measures of Sediment Contamination, Toxicity and Infaunal Community Composition in Puget Sound*, 16 Marine Pollution Bull. 405 (1985).

34. The AET approach has been widely reported in the literature. The best summary of its development and use may be found in PTI Environmental Services, Briefing Report to the EPA Scientific Advisory Board: The Apparent Effects Threshold Approach (Bellevue, Washington, 1988).

35. To be precise, the AET specifies the criteria to be equal to the contaminant concentration above which adverse effects on biota are noted. An adverse effect is a statistically significant difference

to establish criteria for both minimal and severe biological effects.

The AET and SQT approaches provide good means for evaluating the effects of chemical mixtures in sediments and can be used for any contaminant and any species. They also require both laboratory and field analyses of biological response to contamination, thus providing a control and a field situation to evaluate effects of unmonitored environmental variables (e.g., salinity). Interim criteria established primarily by the AET method and partially with sediment equilibrium partitioning are under consideration for adoption in Puget Sound by the State of Washington.[36] These approaches, however, suffer from many of the same problems as the SLC and bioassay techniques. They are site-specific, they do not discriminate between effects of individual chemicals, results may be skewed by unmonitored contaminants, and the procedures are costly. EPA's Scientific Advisory Board has recommended the AET approach for use at specific sites, but determined that because the developed criteria do not necessarily represent cause and effect relationships, the AET should "not be used to develop general, broadly applicable sediment quality criteria."[37]

Present Status of Criteria Development

At the moment, the sediment equilibrium partitioning and AET/triad approaches are receiving the most regulatory interest, although research into all the evaluative techniques continues. The partitioning approach provides a universal standard that requires a large initial cost in research, but would be relatively inexpensive to apply once criteria are set. Unfortunately, like the water quality standards it is based on, it is not well suited for assessing the effects of chemical mixtures and may be based on assumptions that are occasionally false. In contrast, AET/triad-type techniques provide good site-specific criteria, but cannot be applied on a general basis, which means that costs of wide-scale implementation could be prohibitive. A major thrust of ongoing research is to develop standardized methods and numerical criteria that can be applied universally.

Present approaches have different strengths and most scientists recommend using several of the techniques in a tiered fashion to evaluate sites.[38] EPA and the Corps, for example, have adopted a tiered protocol for evaluating whether dredge spoil can be disposed of at open ocean sites.[39] The evaluation consists of a series of steps that become progressively more complex and costly, moving from simple physical and chemical analyses of sediments to long-term bioaccumulation studies.[40] It is important to note that although EPA and the Corps have agreed on a specific protocol for disposal of dredge sediments in the open ocean, there is still significant debate between and within agencies regarding evaluative protocols for sediments not destined for marine dumping. Even within EPA, each of the methods discussed above is being tested or used by different divisions and regional offices.

To date, the relative strengths of the different methods have been largely judged on the basis of economic and biochemical factors. As the various techniques for identifying contaminated sediments move beyond the theoretical phase and are used to regulate sediments and enforce cleanup measures, it is inevitable that the legal basis for regulating sediment contamination will be challenged.

The Legal Basis for Regulating Sediments

Given the pervasiveness of contaminated sediments and their potential environmental and economic impacts, it is remarkable that the legal and legislative communities have generated so little commentary on the regulation and remediation of contaminated aquatic sediments. With the exception of dredge and fill materials and activities, there is little legal precedent, or research specifically addressing who has the authority to develop sediment criteria and evaluative protocols, what sediments should be covered by these standards, and how sediment quality standards may be enforced to control discharges and force remedial efforts. In the absence of specific laws and regulations regarding contaminated sediments, regulators have largely justified their actions on provisions in existing laws, many of which do not explicitly address the issue of regulating sediments. This section outlines federal legislation frequently cited by regulators as the legal basis for governmental intervention in sediment management.[41]

Authority to Inventory and Evaluate Sediment Quality

The authority to inventory contaminated sediments and the authority to develop procedures or numerical criteria for evaluating sediment quality are closely intertwined. Without the protocols for evaluating sediment quality, no inventory can be completed. Thus, when an agency is authorized to conduct inventories of contamination in water or sediments, it is by implication authorized to develop evaluative procedures.

Historically, the authority to inventory sediment pollution and develop evaluation procedures has largely been delegated to the Corps and EPA. However, some state natural resource agencies have taken the lead in recent years. The Corps' authority evolved out of its long history

(P' 0.05) between conditions in a study area relative to conditions in an appropriate reference area. *See* S. BECKER, R. PASTOROK, R. BARRICK, P. BOOTH & L. JACOBS, CONTAMINATED SEDIMENTS CRITERIA REPORT 10 (PTI Environmental Services, Bellevue, Washington, 1989).

36. WASHINGTON DEPARTMENT OF ECOLOGY, INTERIM SEDIMENT QUALITY EVALUATION PROCESS FOR PUGET SOUND (1989).

37. SEDIMENT CRITERIA SUBCOMMITTEE, EVALUATION OF THE APPARENT EFFECTS THRESHOLD (AET) APPROACH FOR ASSESSING SEDIMENT QUALITY 1 (U.S. Environmental Protection Agency, Scientific Advisory Board, SAB-EETFC-89-027, 1989).

38. *See, e.g.*, Chapman (1989), *supra* note 15.

39. *See* 40 C.F.R. §220 *et seq.* (ocean dumping guidlines under the Ocean Dumping Act); 40 C.F.R. §230 *et seq.* (disposal guidelines under the FWPCA).

40. *See* U.S. ENVIRONMENTAL PROTECTION AGENCY, ECOLOGICAL EVALUATION OF PROPOSED DISCHARGES OF DREDGED MATERIAL IN OCEAN WATERS (Draft Report) (Office of Marine and Estuarine Protection, 1989). The Corps' protocol regarding disposal of dredge material is summarized in N. FRANCINGUES, M. PALERMO, C. LEE & R. PEDDICORD, MANAGEMENT STRATEGY FOR DISPOSAL OF DREDGED MATERIAL: CONTAMINANT TESTING AND CONTROLS (Miscellaneous Paper D-85-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, 1985) [hereafter FRANCINGUES].

41. A survey of regulators' views on which legislation gives them the authority to regulate sediments is contained in COWAN & ZARBA, FINAL REPORT ON REGULATORY APPLICATIONS OF SEDIMENT QUALITY CRITERIA (Battelle, U.S.E.P.A. Contract No. 68016986, 1987).

of maintaining the nation's navigable waters, which often required the dredge and disposal of aquatic sediments as stipulated by the Rivers and Harbors Act of 1899.[42] Prior to the late 1960s, issues of sediment quality and the environmental effects from dredge disposal received little, if any, attention. As discussed by Engler,[43] and Ablord and O'Neill,[44] the increased environmental awareness of the 1960s rapidly changed this perspective. In 1968, the Corps enlarged the scope of its review process to include evaluating the effects of sediment dredging and disposal activities on fish and wildlife, pollution, esthetics, and ecology.[45] The National Environmental Policy Act (NEPA)[46] of 1969 required the Corps to conduct environmental impact statements when its activities might significantly affect the quality of the human environment. In 1970, amendments to the Rivers and Harbors Act explicitly authorized the Corps to develop techniques for assessing the environmental effects of dredged material disposal. Further, the Marine Protection, Research, and Sanctuaries Act (MPRSA)[47] and the Federal Water Pollution Control Act (FWPCA)[48] mandated that the Corps consult with EPA in developing approaches to evaluate the effects of discharging dredge materials into ocean and inland waters. Moreover, the MPRSA specifies that criteria for ocean dumping must be updated every three years. Under §103 of the MPRSA, the Corps is also required to develop regulatory criteria for marine dredge disposal as mandated by the 1975 international Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Dumping Convention).[49] The Corps' authority to participate in the development of sediment quality evaluation techniques was further enhanced by §404 of the FWPCA,[50] which authorizes development of methods to prevent adverse impacts from the discharge of dredge materials.

Like the Corps, EPA takes its mandate to develop evaluative techniques for dredge sediments from the FWPCA, the MPRSA, and the London Dumping Convention. EPA, however, is interested in protecting all aquatic resources, not just those subject to dredging and dumping. To justify this broader authority, EPA turned to FWPCA §304, which directs EPA's Administrator to develop "criteria for water quality" for "pollutants in any body of water."[51] EPA has interpreted these phrases to include "river bed, lake bed and wetland substrate" based on "the principle that the [FWPCA] should generally be construed broadly to achieve its purposes."[52] The authority to inventory contamination or to develop a set of sediment criteria or evaluative methods is also directly mandated or implied by the FWPCA in §104, which authorizes the EPA Administrator to conduct and promote research on the effects and extent of pollution. In addition, §115 gives EPA the authority to identify the location of in-place pollutants, and §118 requires annual reports on the status of Great Lake sediments. Moreover, §305 mandates biennial state reports on bodies of water in violation of state water quality standards, and §319 requires reports on environmental problems associated with nonpoint source pollution. Development of testing procedures is also authorized in §4 of the Toxic Substances Control Act (TSCA).[53] A partial summary of legislation that may be used to justify development of sediment evaluation procedures is shown in Table 1.

Sediments and Sites Subject to Regulation

In contrast to the extensive amount of thought and effort put into developing sediment criteria, relatively little research or commentary has examined implementation of these criteria—with the exception of dredge materials. Dredging locations and types of dredge sediments subject to sediment quality evaluation are relatively well defined under existing codes and legislation. Under the FWPCA (Table 1), permits to dredge and dispose of dredge material are subject to sediment quality evaluation. In these cases, the regulatory authority is clearly limited to sediments in dredging or disposal areas. Dredging sites are largely confined to ports, navigation channels, and other congressionally mandated locations. Disposal sites are limited to areas that have undergone environmental evaluation as stipulated by §404 of the FWPCA and §103 of the MPRSA. The MPRSA and the London Dumping Convention prohibit dumping of highly radioactive wastes, or chemical or biological warfare agents. Materials that are not chemically contaminated need only be evaluated for compatibility with the disposal site and do not need to undergo complete sediment quality evaluation.[54]

However, outside of dredging areas, basic issues as to what types of sediments may be regulated, where they may be regulated, and when they may be regulated have not been raised. Defining the boundaries where sediments may be regulated will be a major point of contention in areas such as marshes, wetlands, floodplains, tidal flats, and ephemeral streams that are not permanently inundated, but are occasionally submerged and environmentally linked to adjoining aquatic environments.[55] Many of the mining operations in the western United States, for example, have introduced large quantities of heavy metals into such stream beds, which only occasionally contain water. Attempts to apply submerged sediments criteria to these dry land areas will encounter both scientific and legal criticism.[56] Alternatively, these areas cannot be ignored,

42. 33 U.S.C. §401 *et seq.*
43. Engler, *supra* note 15, at 144.
44. Ablord & O'Neill, *Wetland Protection and Section 404 of the Federal Water Pollution Control Act Amendments of 1972: A Corps of Engineers Renaissance*, 1 VT. L. REV. 51 (1976).
45. 33 C.F.R. §209.120(d) (1968).
46. 42 U.S.C. §§4321-4370a, ELR STAT. NEPA 001-012.
47. 33 U.S.C. §§1401-1445.
48. 33 U.S.C. §§1251-1387, ELR STAT. FWPCA 001-065.
49. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Dec. 29, 1972, 26 U.S.T. 2403, T.I.A.S. No. 8165, 1046 U.N.T.S. 120; *see also* EDGAR & ENGLER, AN UPDATE ON THE LONDON DUMPING CONVENTION AND ITS APPLICATION TO DREDGED MATERIALS (Proceedings Dredging 19 Conference, American Society of Civil Engineers 14, 1984).
50. 33 U.S.C. §§1251-1387, ELR STAT. FWPCA §§001-065.
51. *See* C. Winer, Memorandum to David K. Sabock, Chief, Criteria and Standards Section, U.S. Environmental Protection Agency, Subject: Development of Sediment Criteria (Oct. 25, 1984) (available from Criteria and Standards Division, U.S. EPA).
52. *Id.* at 2.
53. 15 U.S.C. §2603, ELR STAT. TSCA 004.
54. EDGAR & ENGLER, *supra* note 49.
55. Marcus, *supra* note 25.
56. To date, I am aware of only one case, the Sullivan's Ledge Superfund site in New Bedford, Massachusetts, where methods developed

Table 1: Federal Legislation Providing Possible Authority to Manage Contaminated Sediments[a]

			Discharge Controls/Monitoring			Site Remediation	
Legislation and Section	Develop Evaluation Procedures	Identifying Contamination Problems	Point Source	Nonpoint Source	Sediment & Dredge Disposal	Dredge Permits	Sediment Cleanup[b]
Clean Water Act and Amendments							
101						X	
104	X						X
115		X					X
117		X					
118	X	X					X
301		X	X				
303/304	X	X	X				
305		X					
311		X					
314		X	X	X			
319		X		X			
320		X					
401			X				
402			X		X		
404		X			X	X	
405					X		
509					X		
Marine, Protection, Research, and Sanctuaries Act							
102					X		
103	X				X		
201	X						
202	X						
301		X					
Comprehensive Environmental Response, Compensation, and Liability Act/ Superfund Amendment and Reauthorization Act							
102/103		X			X		
104		X					X
105		X					X
106		X					X
107		X					
121	X				X		X
205					X		
Resource Conservation and Recovery Act							
1006		X			X		
1008	X				X		
3001	X						
3002			X				
3004		X	X		X		X
3005					X		
3008			X				X
3019	X	X	X		X		
7003		X			X		
Toxic Substances Control Act							
4	X						
5,6			X	X	X		
Federal Insecticide, Fungicide, and Rodenticide Act							
3			X	X			
Clean Air Act and Amendments							
112			X	X			

[a] Modified from Cowan and Zarba, *supra* note 42, at 15.
[b] Including authorization for demonstration and experimental remedial efforts.

because they introduce large quantities of contaminants into aquatic systems. Wide-spread attempts to regulate and clean up aquatic sediments will require codification of what constitutes an aquatic sediment for regulatory purposes and what techniques should be used to evaluate sediment quality in different portions of these systems (e.g., in floodplains, marshes, and stream bottoms).

On a smaller scale, even if an area has been clearly defined as falling within the regulatory authority of an agency, the issue of where and when sediments at that site are sampled can be a major point of contention. For example, when using equilibrium partitioning or laboratory assays to evaluate sediment quality, the location of sites can substantially alter the test results. Sediment composition, particularly in moderate and high energy environments (e.g., stream bottoms), is notoriously heterogeneous in size. Because contaminants tend to concentrate in fine sediments and composition may vary widely over short distances, samples from adjacent sites may contain widely varying concentrations of contaminants.[57]

The timing of sample collection can also be critical to test results. In the most extreme example, dry period sampling of dry streams will indicate high sediment contaminant concentrations, because much of the dissolved load is left behind on sediment surfaces as the water is lost to evaporation and percolation. Even in permanently submerged bottom sediments, contaminant concentrations may change during high or low energy conditions as fine particles are scoured or deposited. Given the wide extent of sediment contamination and growing governmental intervention in forcing sediment cleanups, it is only a matter of time before issues of location, timing, and sampling generate legal challenges to sediment quality standards and their application in defining and regulating contaminated sediments.

Authority to Enforce Source Control and Remediation

With the exception of dredge materials, few laws or regulations exist that explicitly outline governmental authority to enforce sediment cleanup. In a survey of regulators, most stated that their authority to enforce sediment remedial efforts derived from laws aimed at protecting water quality, with over 75 percent of those surveyed citing the MPRSA and the FWPCA.[58] The MPRSA, the FWPCA, and other laws provide regulators with two potential mechanisms for managing contaminated sediments: discharge controls, and site cleanup and restoration (Table 1).

Source controls are the first step in mitigating sediment contamination, because it makes little sense to restore a site if ongoing pollutant discharges will recontaminate it. A key issue in justifying source controls on water discharges and air emissions will be the linkage of those emissions to downstream contamination of the aquatic sediments. This can be a difficult point to prove, especially in areas where multiple sources exist.

If the linkage can be well defined, several pieces of legislation provide potential regulatory tools for controlling discharges. The FWPCA has provisions that might be used to implement controls on discharges with local and watershed scale sediment impacts. Nonpoint controls might be instituted under §319 of the FWPCA, which requires states to develop nonpoint source management programs, although this section provides weak enforcement options. Sections 303 and 402 provide potentially more powerful weapons for curtailing point source discharges that contaminate sediments. Under these sections, equilibrium partitioning sediment criteria might be used as a basis for setting waste load allocations and granting national pollution discharge elimination system (NPDES) permits, much as present water quality criteria are used to regulate point source discharges.[59]

However, the granting of discharge permits on the basis of sediment quality criteria will be problematic. The scientific protocol for using sediment quality criteria to set discharge limits on contaminants in water is, at best, unclear. Moreover, discharges in compliance with NPDES permits based on water quality criteria can generate contaminant levels in sediments that violate sediment quality standards. For example, long-term low-level releases to river waters may gradually accumulate to dangerous levels in sediments. NPDES permits based on sediment quality criteria in this case could be very restrictive.

Both the Resource Conservation and Recovery Act (RCRA)[60] and the Comprehensive Environmental Response, Compensation, and Recovery Act (CERCLA)[61] might be used at local sites to reduce or eliminate sediment contaminating discharges. Under RCRA, EPA can force operators of treatment, storage, or disposal facilities for hazardous wastes to restrict or cease operations that are polluting groundwaters or surface waters. CERCLA provides similar provisions at abandoned waste sites, although preventive measures generally are not taken unless contamination is bad enough to place the site on the Superfund National Priorities List.

Discharges of substances that contaminate sediments on a regional or national basis could potentially be regulated under TSCA, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA),[62] or under the Clean Air Act.[63] Under § 5 of TSCA, discharges can be limited by restricting the use of chemicals or by totally banning their production, as with the production of PCBs. Likewise, pesticides with widespread distribution in sediments might also be regulated under FIFRA, which empowers the federal government to restrict where and when biocides can be used. Provisions of the Clean Air Act might be invoked to curtail emissions linked to widespread contamination of sediments.[64]

Once contaminated discharges have been curtailed, remedial steps can be taken. Remediation may consist of in-place treatment or removal and disposal at another site. On-site treatment is largely regulated through CERCLA's

for aquatic sediments were applied to intermittent stream and marsh soils. Use of equilibrium partitioning criteria to define contaminated soils at the site was strongly challenged at the Scientific Advisory Board meeting evaluating the EP approach.

57. *See* Marcus, *supra* note 25, at 709.

58. Cowan & Zarba, *supra* note 41, at 10.

59. Gilford & Zeller, *Information Needs Related to Toxic Chemicals Bound to Sediments—A Regulatory Perspective* in Dickson, *supra* note 12, at 35.

60. 42 U.S.C. §§6901-6992k, ELR Stat. RCRA 001-050.

61. 42 U.S.C. §§9601-9675, ELR Stat. CERCLA 001-075.

62. 7 U.S.C. §136-136y, ELR Stat. 001-034.

63. 42 U.S.C. §§7401-7642, ELR Stat. 001-052.

64. Gilford & Zeller, *supra* note 59.

remedial investigation/feasibility study (RI/FS) process, which requires evaluation of remedial approaches on environmental and cost/benefit bases. Disposal of contaminated dredge materials from navigation channels and ports is specifically regulated under the MPRSA, the FWPCA, and the London Dumping Convention (Table 1). In addition, §§5 and 6 of TSCA provide that materials with certain PCB levels must be incinerated or disposed of in a TSCA/RCRA-approved site or an alternative facility approved by the EPA regional administrator. Furthermore, under RCRA, any hazardous waste must be disposed of in a RCRA-approved site. RCRA's definition of hazardous waste can be very restrictive and can make disposal of dredge material prohibitively costly in many cases. The Corps' position is that dredge materials are not a solid waste, but are natural and therefore exempt from RCRA requirements. It is likely that the potential legislative and administrative conflicts resulting from managing extremely contaminated sediments in navigable channels and ports have not yet been fully played out.

As regulators become more aggressive in pushing for sediment cleanups in the coming decade, it is likely that industry will challenge the government's right to regulate sediments. Legal challenges will doubtlessly exploit the fact that existing laws do not specifically address issues of sediment contamination. Courtroom arguments will focus on the inaccurate scientific documentation of sediment contamination due to sampling problems, insufficient proof that contaminant levels in sediments are environmentally harmful, and inadequate linking of industrial discharges to sediment contamination. Scientific arguments will also focus on the costly and uncertain status of efforts to remediate sediment contamination.

Sediment Remediation

The development of remediation techniques for contaminated aquatic sediments is recent. The range of cleanup responses to the contamination of aquatic sediments include no action, in-situ containment and/or treatment, and dredging and disposal, sometimes with treatment.[65] Sediment treatments alter the contaminant load by reducing the sediment volume or by destroying, extracting, or immobilizing the contaminant.[66] There are few widely accepted cleanup techniques, so attempts to remediate sediment pollution can easily bog down in a morass of uncertainty. Major issues confronting sediment cleanups include the following: causing damaging environmental side effects from sediment removal or treatment; allocating remediation costs; choosing among various remedial measures in the absence of clear criteria and experimental evidence; setting appropriate cleanup goals; and finding appropriate remediation methods for extremely large volumes of low-level contaminated sediments (in contrast to the relatively small volumes of extremely contaminated sediments for which techniques have been developed at Superfund sites). The following sections outline the basic nature of the cleanup techniques, the situations in which those techniques are considered most appropriate, and some problems associated with different cleanup measures.

The No-Action Approach

The no-action approach is a viable option that should be given serious consideration in the context of contaminated aquatic sediments. It is viable because natural sedimentation may bury and contain the pollutants, and natural degradation and solution processes can sometimes reduce contaminant loads. For example, 13 years of fishing restrictions in Virginia's James River were lifted in 1988 when natural dilution and burial by clean sediments reduced kepone concentrations in surface sediments to tolerable levels.[67] The no action option is appealing because of its low cost and because it entails none of the environmental side effects associated with dredging or capping procedures. Measures required to remediate the 500 km^2 of kepone in James River sediments, for instance, would have adversely affected large areas of benthic habitat and cost between $3 billion and $9 billion.[68]

"No-action," as used in sediment mitigation jargon, may be misleading. Although no direct actions are taken to confine, remove, or treat sediments at the site, substantial activity may be directed at preventing further pollution or mitigating pollutant effects. In particular, it is essential that the polluting discharge be halted in the no-action scenario, because the sediments will continue to be repolluted even as natural processes cleanse them. Moreover, efforts to secure the polluted area to prevent human contact or contamination of wildlife may be necessary until the area is relatively clean. Securing such areas may have far-reaching effects, as with the commercial fishing ban in response to James River kepone contamination. Natural processes of sediment mixing and burial may also be encouraged in order to dilute or to cover the contaminated sediments. Although contrary to most environmental policy, maintaining a constant or accelerated input of clean sediments to contaminated systems can provide a rapid burial system. If the polluted area is small, silt curtains or flocculents can also be used to enhance sedimentation and burial of the contaminated sediments.[69]

The no-action alternative is appropriate when natural processes will substantially reduce the environmental effects of polluted sediments within a reasonable time. No-action is therefore suitable when the polluting discharge has been halted, when natural burial or dilution processes are rapid, and when the contaminated sediments will not be remobilized by human or natural activities. This final factor can be troublesome, especially when pollutants are located in navigation ways that require periodic dredging that reintroduces buried contaminated sediments to surface waters. The no-action alternative is also appropriate when environmental impacts of sediment cleanup are more damaging than allowing the sediments to remain in place. The process of dredging or treating sediments can lead to

65. Literature on sediment remediation is often hard to access, being buried in in-house company and governmental documents or in RI/FS reports and environmental impact statements. Probably the best overview and introduction to sediment cleanup techniques is found in National Research Council, Contaminated Marine Sediments—Assessment and Remediation (1989) [hereafter NRC].

66. A good summary of existing and experimental treatment alternatives is in International Joint Commission, Options for Remediation of Contaminated Sediments in the Great Lakes (Great Lakes Regional Office, Windsor, Ontario, 1988) [hereafter IJC].

67. *See* Huggett, *Kepone and the James River*, in NRC, *supra* note 65, at 417.

68. *Id.*

69. NRC, *supra* note 65, at 46.

widespread destruction of aquatic wildlife,[70] while disposal of the sediments can destroy valuable habitat.

In-Place Controls

Possible in-place controls consist of containment, treatment, or combinations of the two. In practice, in-place treatment of contaminated aquatic sediments has been carried out only at experimental levels or on small scales, and most management agencies do not presently consider it a viable option.[71] In-place controls therefore generally focus on containment.

Contaminated sediments can be contained by placing a cap over the sediments or by combining capping with lateral confining structures, such as dikes.[72] Lateral confinement is necessary in cases where contaminated and cap materials might spill (e.g., on sloping surfaces) or be disturbed (e.g., in shallow waters subject to wave action). Lateral confining structures also help ensure that cap materials are properly placed and effectively cover the contaminated sediments.

Capping is generally accomplished by dumping clean sands or silts on top of the contaminated sediments. Silt caps need to be thicker because currents can easily displace the materials, and because silts are bioturbated to a greater depth.[73] Long-term monitoring of a number of sites in New England indicates that capping with silts and sands can effectively contain contaminated sediments over a period of 10 years. At smaller sites, flexible hollow containers may be laid over a site and filled with grout to confine the sediments. Active cap materials can also be used that inhibit the contaminant flux from sediments to overlying waters. Lime or calcium carbonate caps, for example, increase the pH of nearby waters and decrease the solubility of metals.[74] Addition of calcium carbonate or aluminum sulfate has also been shown to reduce the phosphorous flux to overlying waters and eutrophication.[75] It is possible that a cap with activated carbon will reduce contaminant flux to the water column, although experiments on this have been conducted only at the laboratory scale.[76]

Confinement is appropriate if:

- the no-action option does not provide sufficient protection;
- polluting discharges have been halted;
- the cost and environmental effects of moving or treating the sediments are too great;
- sources of capping materials are available;
- hydrologic conditions will not disturb the site; and
- the area is not subject to dredging.

In some cases, capping can be used for habitat enhancement, as at the St. Paul Waterway Superfund site in Washington, where clean sediments will be used to create a large intertidal area with varying substrates for aquatic biota.[77]

Problems associated with capping generally result from inaccurate emplacement of the cap (particularly in deeper waters) or erosion of the cap. Confinement options must always be accompanied by long-term monitoring plans to ensure that sediments remain in place and that contaminants do not bioaccumulate in local biota. Cost allocation is also problematic. Covering costs of sediment capping is further complicated by the fact that capping probably does not constitute a "preferred treatment" under §121 of CERCLA, which provides for Superfund contributions to capping programs.[78]

Experimental in-place treatments have primarily focused on solidifying the sediments or on immobilizing the contaminants. Setting agents, such as cement, can be added to sediments to physically solidify and sometimes chemically immobilize the contaminants. However, difficulties with generating correct mixtures of water, setting agent, and sediment in subaqueous settings limit application of this technique. In-place solidification has been practiced with success in Japan, but this work did not address chemical mobility.[79] Bacteria have been tested in attempts to immobilize metals by converting them into insoluble sulfides.[80] Problems associated with in-situ treatments are largely a function of their unproven nature. Little is known about costs of large-scale treatments, their effectiveness, or possible toxic by-products from treatment processes.

Removal, Disposal, and Treatment

Most research and regulatory emphases on remediation of contaminated aquatic sediments have focused on dredging and disposal techniques. In particular, the Corps' Waterways Experiment Station has investigated contaminated dredge removal[81] and disposal[82] since the early

70. Dredging and treatment of PCB-contaminated sediments in the Hudson River, for example, decimated benthic flora and fauna, which only reached their predredge contaminated sediment population levels three years after dredging. If the primary goal had been to protect benthic wildlife, such actions would have had questionable merit. *See* Carcich & Tofflemire, *supra* note 2.

71. *See, e.g.*, Orchard, *Remedial Technologies Used at International Joint Commission Areas of Concern*, in NRC, *supra* note 65, at 280.

72. Good diagrams of standard capping and confinement configurations and associated containment problems are contained in Cullinane, Averett, Shafer, Truitt, Bradbury & Male, *Alternatives for Control/Treatment of Contaminated Dredged Material*, in NRC, *supra* note 65, at 234.

73. Morton, *Monitoring the Effectiveness of Capping for Isolating Contaminated Sediments*, in NRC, *supra* note 65, at 262.

74. IJC, *supra* note 66, at 36.

75. *See* Kennedy & Cooke, *Control of Lake Phosphorous With Aluminum Sulfate: Dose Determination and Application Techniques*, 18 Water Resources Bull. 389 (1982); T. Murphy, K. Hall, K. Ashley, A. Mudroch, M. Mawhinney & H. Fricker, In-lake Precipitation of Phosphorous by Lime Treatment 85 (National Water Research Institute, Environment Canada, Burlington, Canada, 1985).

76. Mackenthun, Brossman, Kohler & Terrell, Approaches for Mitigating Kepone Contamination in the Hopwell/James River Area of Virginia, Proceedings of the Fourth U.S./Japan Meeting on Management of Bottom Sediments Containing Toxic Substances (Water Resources Support Center, U.S. Army Corps of Engineers, 1979).

77. *See* Ficklin, Weitkamp & Weiner, *St. Paul Waterway Remedial Action and Habitat Restoration Project*, in NRC, *supra* note 65, at 440.

78. NRC, *supra* note 65, at 16.

79. Otsuki & Shima, Soil Improvement by Deep Cement Continuous Mixing Method and its Effect on the Environment, Proceedings of the Sixth U.S./Japan Experts Meeting on Management of Bottom Sediments Containing Toxic Substances (Water Resources Support Center, U.S. Army Corps of Engineers, 1982).

80. Acres Consulting Services Limited, Evaluation of Procedures for Removing and Decontaminating Bottom Sediments in the Lower Great Lakes, (Niagara Falls, Ontario, 46, 1972).

81. *See* D. Hayes, Guide to Selecting a Dredge for Minimizing Resuspension of Sediment, Environmental Effects of Dredging Program (Technical Note EEDP-09-1) (U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi, 1986).

82. Summarized in Francingues, *supra* note 40.

1970s. Treatment options for dredge material have been investigated on a more ad hoc basis, generally in association with Superfund sites.

The removal of contaminated sediments is appropriate when environmental impacts are severe, environmental conditions such as wave turbulence or flooding and associated scour prohibit leaving the sediments in place, or sediments are located in navigation ways that must be dredged. A variety of dredges may be used to remove contaminated sediments, with the choice of dredge dependent on the nature of the sediment and contaminant, the depth to bottom, the thickness and volume of sediments, the distance to disposal site, and available machinery. Many of the best dredges for removing contaminated sediments have been developed by the Dutch and Japanese, but cannot be used in the United States because of trade restrictions.[83]

The biggest environmental problem associated with dredging of contaminated sediments is resuspension of the sediments and the resulting loss of volatiles and solubles to the water column. Resuspension occurs due to dredge action at the sediment-water interface, during transfer of the sediment to a storage vessel, due to slop or leakage from the vessel, and during disposal. Water contamination by volatiles is generally less with mechanical dredges, which cut the sediments with an augur or blade. Hydraulic dredges are less likely, however, to introduce solubles to the water column.[84] The price of contaminated dredge removal can pose obstacles, with costs ranging from $11.50 to $23.00 per cubic yard, as compared with $1 to $2 per cubic yard for removal of clean sediments.[85]

Transportation of the dredge materials can be by boat, truck, rail, or pipeline. A major concern in transporting the dredge material is spillage, particularly during loading and unloading operations. In some cases, decontamination of sediment-handling equipment is required. Chemical changes during transport are also a concern. Dewatering, for example, can lead to oxidation of sediments and increased solubility of the contaminants at the disposal site.[86]

Contaminated sediments may be disposed of in aquatic, nearshore, or upland dumping sites. Relatively clean contaminated sediments can be disposed of at unconfined aquatic sites.[87] More polluted sediments require confinement and/or treatment. As with in-place controls, confinement of dredge materials at subaqueous sites consists of capping and lateral enclosure. Problems not encountered with in-place confinement include resuspension of contaminated sediments during emplacement and the difficulty of placing the contaminated materials precisely within the boundaries of the containment facility.

There are several advantages to using confined shoreline facilities rather than subaqueous sites for disposal. Transport distances to nearshore disposal sites are often less because contaminated sediments frequently are located in shallow water harbors close to the shore. Water column contamination during emplacement of contaminated sediments is reduced because sediments are not dropped through a substantial depth of water. Accurate emplacement and monitoring are also easier at nearshore sites. Confined disposal facilities (CDFs), which effectively cap and isolate the contaminated materials, can also create valuable wildlife habitat. At other sites, however, the appearance of good wetlands habitat has attracted wildlife that became contaminated by the sediments or microorganisms in the confined shallow waters and mudflats. Securing CDFs from use by humans and wildlife can be a major concern.

Construction of numerous CDFs in the Great Lakes in the 1970s demonstrated that nearshore disposal can be environmentally effective and relatively cost efficient. Costs of constructing the sites (not including land acquisition, engineering, transport of sediments, etc.) in the United States have ranged from $0.38 to $11.47 per cubic yard.[88] In some cases, the value of the newly created land has offset these costs.

At upland disposal sites, extremely toxic materials can be disposed of in hazardous waste dumps if sediment volumes are small. Upland disposal options for less contaminated sediments or sediments with relatively immobile contaminant loads include upland confined disposal; use for quarry or stripmine reclamation; soil enhancement in agricultural fields; beach nourishment; and creation of recreation sites (e.g., sledding hills). Bioaccumulation and toxicity must be especially attended to when using dredge material for agriculture. Guidelines already exist for permissible metal levels in sludge applications to agricultural crops intended for consumption.[89] Alternatively, the dredge material can be used for nonconsumptive crops (e.g., sod farms).

Similar problems confront both nearshore and upland disposal.[90] Land acquisition can be difficult, particularly in already built-up nearshore areas. Permitting also poses problems, especially in the face of new wetland protection acts that restrict nearshore activities and the growing pervasiveness of the "not-in-my-backyard syndrome." Transportation to upland sites can be very expensive. Environmental problems confronting nearshore and upland disposal sites are the standard ones associated with waste facilities. They include controlling contaminant migration in groundwater and surface runoff, preventing erosion from gullying or wave action, and preventing plant and animal uptake of contaminants. Dredge sediments for landfills may have significant dewatering requirements, since contaminated materials classified as "liquid" by the RCRA paint filter liquid test may not be disposed of in landfills.

Several techniques exist for treating dredge materials. These techniques work either by separating the fine sediments carrying contaminants from the dredge material and thus reducing the waste volume, by immobilizing the pollutants, by extracting the contaminants and recycling

83. For the types of dredges for removing contaminated sediments and their relative merits and weaknesses, *see* Herbich, *Developments in Equipment Designed for Handling Contaminated Sediments*, in NRC, *supra* note 65, at 239, and Cullinane et al., *supra* note 72. Herbich provides sketches of dredges for the novice and had a useful table outlining performance specifications for the different types of dredges.

84. Cullinane et al., *supra* note 72.

85. IJC, *supra* note 66, at 18. Table 4 of this document also provides a useful overview of the range of costs associated with different dredging, confinement, disposal, and treatment techniques for contaminated sediments.

86. FRANCIOUSI, *supra* note 40, at 19.

87. Cullinane et al., *supra* note 72.

88. IJC, *supra* note 66, at 19.

89. *Id.* at 23.

90. *See* FRANCIOUSI, *supra* note 40, at 21-27.

them, by destroying the contaminants, or by some combination of the above. Different treatments are appropriate for different contaminants. For example, stream stripping and biodegradation are only appropriate for organics, while magnetic separation and ion exchange techniques are designed for metals. As with in-situ treatments, most treatment techniques for dredge materials are experimental or have only been used at Superfund sites for small volumes of sediment with high contaminant concentrations. It is not yet clear whether these techniques are economically or scientifically feasible for large volumes of dredge material with low contaminant levels.

Separation of contaminated fine sediments can be accomplished with settling basins (where the coarse load settles out first and the fine load is decanted), with clarifiers to separate the water and sediments, with belts or screens that sieve the sediments, and with hydrocyclones that centrifuge the sediments.[91] Solidification with setting agents, such as cement, fly ash, slag, and lime, has proven feasible in field situations, with costs ranging from $45 to $75 per cubic yard, not including removal or disposal.[92] Long-term testing of field scale solidified materials has not been carried out, however, and it is unclear whether the process adequately contains contaminants over long periods. Moreover, the chemical effects of setting agents require more research. Lime and fly ash mixtures, for example, tend to increase the solubility of arsenic, chromium, lead, and zinc.[93]

Techniques for extracting or destroying contaminants in sediments have rarely been attempted outside experimental settings, are expensive, and are probably years away from being useful technologies.[94] In general, acid leaching, ion exchange, magnetic separation, electrochemical techniques, and biological and ligand leaching are most effective for heavy metals. Biodegradation, solvent extraction, stream stripping, and thermal treatments are more effective for organics.[95] Costs of these techniques generally range between $150 to $750 per cubic yard, which makes them only feasible for relatively small volumes of very contaminated sediments.

Conclusion

The push to regulate contamination in aquatic sediments is still in its infancy. Many basic questions have not yet been answered regarding the scope of the contamination problem, how to distinquish a clean from a polluted sediment, what the legal basis is for regulating sediments, and how to clean up contamination within sediments. Thus, regulators face much uncertainty in attempting to manage sediment pollution. Statewide, regional, and national planners should take this uncertainty into account and avoid rigid management structures for contaminated sediments that specify any one approach. In the immediate future, the best regulatory stance will be flexible, allowing for the testing of different evaluative techniques, the examination of various regulatory mechanisms, and the comparison of different cleanup techniques.

91. *See* U.S. Environmental Protection Agency, Removal and Mitigation of Contaminated Sediments (Hazardous Waste Engineering Research Laboratory, 1985).

92. IJC, *supra* note 66, at 43.

93. *Id.* at 41.

94. Cullinane et al., *supra* note 72.

95. IJC, *supra* note 66, at 37, 55-65.

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CONTAMINATED MARINE SEDIMENTS--ASSESSMENT AND REMEDIATION

Committee on Contaminated Marine Sediments

Marine Board

Commission on Engineering and Technical Systems

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EXECUTIVE SUMMARY

Contamination of marine sediments poses a potential threat to marine resources and human health (through consumption of seafood) in numerous sites throughout the country--particularly near metropolitan areas. Improving the nation's capability to assess, manage, and remediate these contaminated sediments is critical to the health of the marine environment as well as to its use for navigation, commerce, fishing, and recreation. As widespread as the problem of sediment contamination appears to be, understanding of the geographical extent and ecological significance of the problem is not well developed. In addition, management and remediation of contaminated marine sediments requires grappling with dynamic aquatic environments in which contaminant mobilization can occur in response to remediation itself, or as a result of natural resuspension, transport, and deposition of the bottom sediments.

This report, prepared by the Committee on Contaminated Marine Sediments of the Marine Board of the National Research Council, examines the extent and significance of marine sediment contamination in the United States; reviews the state of the art of contaminated sediment clean-up and remediation technology; identifies and appraises alternative sediment management strategies; and identifies research and development needs and issues for subsequent technical assessment. The report contains the results of a symposium and workshop, with supplementary discussion and recommendations by the convenors.

The committee members concluded that sediment contamination is widespread throughout U.S. coastal waters and potentially far reaching in its environmental and public health significance. A report sponsored by the U.S. Environmental Protection Agency (EPA), although limited in its data sources, estimated that there are "hundreds of sites in the United States with in-place pollutants at concentration levels that are of concern to environmental scientists and managers. More than one-third involve marine or estuarine waterways." The National Oceanic and Atmospheric Administration's (NOAA) National Status and Trends Program, which selectively excluded "hot spots" from its sampling, found high levels of contamination in samples from sites in major urban areas, including Boston, New York, San Diego, Los Angeles, San Francisco, and Seattle. However, adequate data do not currently exist for comprehensively pinpointing or prioritizing candidates for remedial action. Even so, the means and methods for making such determinations are available (or close at hand), albeit needing much improvement. They include several that were evaluated by the committee.

At present, no single technique is widely accepted and each has its advantages and disadvantages. A number of approaches may be needed to evaluate the significance and extent of contamination at any given site. Ultimately the methods used should be able to be conducted routinely and cost-effectively.

In terms of risk to human health, transfer of contaminants from marine sediments to humans is poorly documented and underassessed. However, it appears that there may be cause for concern with regard to persistent bioaccumulative chemicals contaminating seafood. The impact of this type of contamination needs further investigation.

Despite the widespread extent of the contaminated sediment problem, remedial actions directed at excavating, treating, or otherwise manipulating contaminated marine sediments have been extremely rare. Under the Superfund law, only sites designated on the National Priorities List can be funded for remediation. The Hazard Ranking System score, which determines placement on this list, gives heavy weight to potential contamination of drinking water sources, but little or no weight to sediment-mediated contamination of edible fish and shellfish. Furthermore, little effort has been made to identify contaminated sites in coastal environments under Superfund.[1]

In its examination of state-of-the-art clean-up and remediation technology, the committee determined that existing technology is adequate in most situations. However, the committee noted that some specialized dredging equipment--e.g., to allow excavation of contaminated sediments with a minimum of turbidity--is difficult to obtain in the United States (due to cabotage laws). To alleviate this problem, government support is encouraged for efforts to acquire or develop dredging equipment with features that make it well-suited to the excavation of contaminated sediments.

The committee also found that the time required for EPA or its contractors to make a clean-up decision was more often a limiting factor in accomplishing effective clean-up than any constraints imposed by limitations in clean-up science or technology. The time required for a decision was sometimes speeded up, however, where the need for navigational dredging was a driving force.

Remediating underwater sediment contamination can be a complex problem. Failure to make a decision may cause the problem to spread. Although in many instances the problem may correct itself given enough time, it is usually desirable to isolate and contain the contaminated area to the extent possible. Allowing the affected area to expand will generally only serve to increase the cost and complexity of the eventual clean-up. More attention needs to be focused on the design of

[1]Although as many as 141 of 1,100 (13 percent) present and proposed Superfund National Priorities List sites may be located adjacent to coastal areas and may or may not involve coastal sediments, no remedial action has been selected for the great majority of these sites.

rapid short-term actions to limit the spread of contamination at the same time that more elaborate long-term remedies are assessed and developed.

In some cases, no action can be the alternative of choice, assuming measures have been adopted to control contamination sources. This may be particularly true when natural sedimentation or dispersal may mitigate the problem or when natural detoxification of contaminants is occurring. During an evaluation process, the effects due to remediation should be compared with those associated with the no-action alternative.

The committee recommended that future research and development be focused on

- establishing better better biological and chemical techniques for rapidly and reliably assessing the presence and severity of bottom sediment contamination,
- delineating the practical limits of capping as an efficacious remediation technology,
- identifying interim measures to limit the spread of contaminated sediments while long-term remedies are assessed, and
- formulating procedures and guidelines that adequately evaluate and prioritize health and environmental risks associated with sediment contamination, and against which effectiveness and clean-up needs can be measured.

The committee also believed that in view of the high cost of most remedial actions, greater use should be made of benefit-cost comparisons. This would place investment in this area on the same economic footing as investments in other public projects. Cost-effectiveness analysis of alternative remedial actions, including "no action," should consider both short- and long-term costs, comparisons at and among sites, and incremental costs of additional levels of clean-up of contaminated sediments.

Finally, increased emphasis on sediment assessment and clean-up practices has caused rapid changes and developments in state-of-the-art technologies. Developments and experience in methods for applying these technologies are also occurring at a rapid rate. Therefore, it is an important and appropriate role for the federal government (either through individual concerned agencies or, preferably, through a coordinated interagency committee) to frequently review and evaluate the effectiveness and scientific basis for newly developed sediment assessment and clean-up technologies and procedures.

FINDINGS AND RECOMMENDATIONS

EXTENT OF CONTAMINATION

Findings

Many marine sites are known to contain sediments with high levels of anthropogenic chemicals or to have altered biological characteristics. However, there are no generally accepted definitions of contamination that trigger consideration of remedial action. The working definition of contaminated sediments used in this report is those which contain chemical substances at concentrations that pose a known or suspected environmental or human health threat. The sites that require the most urgent attention are those reservoirs of contamination that affect regions or that have the most severe impacts on health and the environment. Pending revisions of the Superfund Hazard Ranking System will facilitate the assessment and prioritization of human health and ecological risks associated with contaminated sediments.

Many contaminated marine sediments are located along all coasts of the contiguous United States, both in local "hot spots" and distributed over large areas. Some of these sites, but not many, have been well characterized. Existing data on individual sites and their contamination vary widely in content and organization. Assessments using available data have been conducted on the national extent of contamination and have identified a partial picture of the total contaminated sediment problem. These studies have shown that a wide variety of contaminants are found in sediments, including heavy metals, polychlorinated biphenols (PCBs), DDT, and polynuclear aromatic hydrocarbons (PAHs). However, no federal agency has assumed the full responsibility of establishing a national inventory of sites with contaminated sediments or a comprehensive assessment of the extent of contamination on a national basis.

A number of state and federal agencies collect data for different purposes and use different approaches. However, sediment contamination data collected for one purpose may be of little relevance or applicability for another because of parameters measured, methods used, or temporal and spatial scales designated. For example, sediment data assembled for setting regulatory criteria or for following national or regional trends may be of little value in detecting site-specific problems or in defining site-specific remediation requirements.

This can be illustrated by NOAA's National Status and Trends Program. As part of this program, NOAA has acquired sediment data from approximately 200 sites around the coasts of the United States (see Robertson and O'Connor, pages 47-62). This information is used to determine broad national- and regional-scale status and trends in sediment contamination levels. However, the network of stations is not sufficiently dense to allow the data to be used to set clean-up priorities or to make site-specific judgments. Indeed, the NOAA program intentionally excluded from its database, sampling stations deemed to be reflective of localized hot spots rather than of broad regional contamination trends. In short, care should be exercised to ensure that data generated by monitoring programs are not inappropriately used beyond the limits or intent of the original monitoring program.

At present, there are no generally accepted and validated sampling techniques, testing protocols, or classification methodologies for determining sediment contamination. A certain uniformity in parameters measured and data reported is desirable to facilitate intercomparisons. This must be accomplished by setting some national standards, criteria, or guidelines.

In general, efforts by states to address potential marine sediment contamination are diffuse and not well focused. For example, most state water quality agencies focus on discharges and impacts to the water column. Thus, little effort is being expended by state agencies on identifying and remediating contaminated marine sites. State hazardous waste agencies are, in most cases, directing their efforts to upland areas so their involvement in marine sediments problems is limited.

Recommendations

Search for Contaminated Sites

The location and extent of contaminated marine sediments have not been comprehensively assessed on a national basis to identify site-specific remediation targets. The federal government should initiate such a program to delineate areas with contaminated sediment. The objective should be neither detailed mapping nor duplication of NOAA's regional National Status and Trends Program. In regions of concern, or in areas of known hot spots, special attention should be directed to identifying and characterizing specific contaminated sites. The search for new sites or the reclassification of known sites should proceed concurrently with remedial action.

Utilization of Federal, Regional, and Local Expertise

Due to the variability in environmental conditions among sites, well-informed local specialists provide a critical complement to our national expertise.. Neither federal, regional, nor local managers can operate effectively in a vacuum. Managers at all levels of government should interact and cooperate and remain receptive to the expertise and concerns of other specialists in assessing or remediating contamination at a particular site.

Coordination of Efforts

An interagency technical committee, including nongovernmental as well as state and federal experts, should be established to evaluate existing and emerging data on sediment contamination. This committee would assemble data, prepare reports, and make recommendations as to the need for and direction of sediment research and monitoring activities, including sediment and sampling assessment methodologies. The objective of the committee would be to focus the limited resources on the most needed research and monitoring, reduce redundancy, and help eliminate improper uses of data.

CLASSIFICATION METHODOLOGIES

Findings

A variety of biological and chemical sediment classification methods are available. Individually or in combination, they attempt to systematically characterize marine sediments with elevated levels of contaminants, and correlate such concentration increases with adverse biological effects. With one possible exception (the acute amphipod bioassay), none of these techniques are routinely used and each has its limitations. Indeed the cost and complexity of a number of these tests virtually ensures that they will be used routinely only at large sites.

Several contaminated sediment classification techniques were examined by the committee: sediment bioassays, sediment quality triad approach, apparent effects threshold technique, and equilibrium partitioning. Each technique is discussed in detail in a presented symposium paper (in this volume) and some of the advantages and disadvanges of each (for remedial action screening and sediment quality criteria development) are set forth in Table 1.

From a remedial clean-up standpoint, the most useful sediment testing and classification procedures would be those that are simple and inexpensive, with rapidly available test results. If sediment quality criteria methodologies are adopted by EPA, a routine basis for establishing the presence of unacceptably high levels of sediment contaminants may be available. The design and implementation of remedial action for contaminated sediments are likely to be delayed and frustrated unless one can readily determine "how clean is clean." Development of an interim working methodology to establish such a criterion would alleviate the delay.

TABLE 1 Assessment of Sediment Classification Methodologies

Classification method	Advantages	Disadvantages
Bioassay	• follows toxicological methods developed for water quality criteria • a direct measure of sediment toxicity • does not require identification of individual contaminants • does not assume a specific route of uptake • acute results available quickly • established test procedures in use for dredged material characterization	• requires development of standard chronic bioassay methodologies • may be more costly than some chemical analyses • difficult to translate laboratory results to natural conditions • difficult to determine chemical effects • does not address human health impacts • results of chronic tests may not be timely • may not identify causative contaminants
Sediment Quality Triad	• based on a combination of laboratory and field data indicating effects of actual contaminated sediments • based on observed biological effects • does not assume a specific route of chemical uptake • applicable to complex mixtures	• limited by the availability of existing data or by the ability to collect large amounts of new data • available data may be of highly variable quality • difficult to translate laboratory results to natural conditions • does not address human health impacts • may not identify causative contaminants

TABLE 1 (Continued)

Classification methods	Advantages	Disadvantages
Sediment Quality Triad (cont.)		• indicators are not independent; covary with grain size and organic carbon content • potentially not comparable between geographic locations • does not consider chemical bioavailability from site to site
Apparent Effects Threshold	• uses existing data (from field and laboratory; e.g., Sediment Quality Triad) • applicable to all chemicals and all biological effects • most useful for prioritizing contaminated areas within a large site • based on observed biological effects • does not assume a specific route of chemical uptake • applicable to complex mixtures	• limited by the availability and quality of existing data • varies with choice of biological effects indicator • relies on correlations/ may not identify causative contaminants • potentially not comparable between geographic locations • may be both over- and under-protective • difficult to translate laboratory results to natural conditions • does not address human health impacts • multicompound interactions not accounted for • Indicators are not independent; covary with grain size and organic content

TABLE 1 (Continued)

Classification method	Advantages	Disadvantages
Equilibrium Partitioning	• provides a chemical specific criterion • utilizes large toxicological data base incorporated in water quality criteria and other toxicological endpoints • relies on well-developed partitioning theory • accounts for the bioavailability of the chemical interest • provides a standard basis for comparison within and among sites • where data are available allows quick and inexpensive characterization • incorporates a built-in "how clean is clean" standard • is a direct measurement of sediment characteristics • can be readily incorporated into existing regulatory frameworks	• does not consider complex mixtures and chemical interactions • currently limited to hydrophobic neutral organic compounds • does not address human health impacts • limited to contaminants for which both water quality criteria (or other suitable toxicological endpoints) and sediment-water partitioning coefficients are available • relies on K_{oc}[a] measurements which are often variable • does not account for contaminant uptake by ingestion of particles or direct absorption/adsorption from sediments • sediment and water may not be at equilibrium with respect to contaminant concentration • does not use toxicological data derived from the sediment of interest • assumption of constant bioaccumulation factor for various contaminants and organisms is questionable

[a]K_{oc}--carbon normalized sediment-water partition coefficient.

Although a variety of methods for assessing contamination are available, there is no single method that is widely accepted and some may be more suited to a particular situation than others. Approaches that develop single numeric criteria often do not provide sufficient data for assessing the overall significance of contamination at a site. A number of approaches may be needed to evaluate the significance and extent of contamination at any given site.

Recommendations

Improved Methodologies

In order to ensure that decision making is informed and scientifically based, continued research and use of assessment methodologies should provide information to determine

- a range of concentrations of chemicals in sediments that will result in biological effects, and
- whether in-place sediments are causing biological impacts.

Additionally, increased efforts should be made to refine methods for sediment classification to be used by regulatory agencies.

Tiered Testing

A tiered approach to the assessment of contaminated sediments should be used. The approach would progress from relatively easy and less expensive (but perhaps less definitive) tests to more sensitive methods as needed.

RISKS TO HUMAN HEALTH AND THE ECOSYSTEM

Findings

The most significant human health risk associated with marine sediment contamination may be ingestion of contaminated fish and shellfish. Many compounds, such as some polyaromatic hydrocarbons (PAHs), may be readily metabolized by enzymatic systems in higher aquatic organisms such as fish, although there is uncertainty about whether they are detoxified. Some invertebrates, such as bivalve mollusks, have only a limited ability to metabolize PAHs and tend to accumulate them to higher concentrations and retain them more. Therefore, consumption of these animals may be a source of human exposure. Trace metals are not degraded and may be bioaccumulated by aquatic organisms and then transferred to humans via consumption of seafood. Reports of "fin rot" and tumors in finfish, particularly bottom-feeding fish in Puget Sound and the New York Bight in recent years, provide further evidence that there may be substantial risk to the ecosystem and potentially to human health due to the contamination in marine sediments. Although there is general consensus that seafoods present a route of transfer of contaminants to humans from contaminated sediments, the extent of risk that is posed is unknown.

In addition to the carcinogenic nature of many of these contaminants, reproductive impairments and other sublethal effects in humans are concerns that require increased attention. Risk assessments of these latter endpoints have not been conducted. Furthermore, inadequate attention has been given to mammalian studies of the long-term chronic effects of ingesting contaminated fish and shellfish. Epidemiological studies of human populations living near contaminated sediment sites also have been under-emphasized.

Assessment of the ecological effects resulting from sediment contamination is an area that needs additional study. This is especially true for soft-bottom communities in trying to correlate ecological impacts with chemical-specific factors. Accumulation of contaminants in marine sediments can cause death, reproductive failure, growth impairment, or other detrimental changes in the organisms exposed to these contaminants. Such changes can impact not only individuals but also entire benthic populations and communities.

Both localized and widespread contamination has in the past resulted in significant population and community changes. Typically this involves the elimination of less tolerant species and an increase in more tolerant species. Such changes can have far reaching, long-term effects on a given ecosystem. Generally, those species that are eliminated have not received the attention they deserve in the assessment of ecological effects. Furthermore, the technical capability has not evolved for interpreting population and community responses in relation to specific chemicals.

Sublethal and chronic effects of contaminants on the marine ecosystem are a significant environmental concern. However, at the present time there are no widely accepted sublethal and/or chronic effects tests available. Much research is being conducted on tests for growth, reproduction, or biological abnormalities. Interpretation of such tests is often difficult and there are few established criteria available to judge the sublethal and chronic effects of contaminants on the marine ecosystem.

Recommendations

Assessment of Risk Due to Contamination

Although the assessment of human health risk is important, a more balanced approach requires greater emphasis on ecosystem impacts. This will require regulatory agencies to utilize new assays being developed to detect and gauge the effect of contamination on physiology (assays such as immune suppression, enzyme induction, and DNA adduct formation), life stage impacts (using parameters such as reproductive success, growth, and recruitment), pathological effects, and changes in community structure.

In terms of risks to human health, consideration should be given to conducting available retrospective human epidemiology studies of exposed populations in the development of an overall assessment and remedial plan.

MOBILIZATION AND RESUSPENSION OF CONTAMINANTS

Findings

The decision to manage contaminated marine sediments in place or to remove and relocate them on land involves consideration of the potential for contaminant mobilization and release to the environment. There is a tendency for heavy metals in marine sediments placed in on-land disposal sites to desorb under changing geochemical conditions (such as decreased pH due to acid formation) and potentially allow chemicals to leach into groundwater. Organic chemicals found in marine sediments tend to maintain relatively constant solubility and mobility potential when disposed of on land. When contaminated sediments are excavated and placed in contact with the air, relatively low concentrations of volatile organics can contaminate the air. The most obvious difference in risks associated with on-land and aquatic disposal of contaminated marine sediments is the greater significance of food chain contamination as an exposure pathway in aquatic disposal.

Estimates of both deposition rates and erosion rates are needed in order to decide whether to remove contaminated sediments. If natural sedimentation causes the rapid burial of contaminated sediments in place, then other remediation may not be needed. However, if the contaminated sediment is subject to resuspension and dispersion, in-place capping or removal may be necessary, even if the contamination is distributed over large areas or long distances.

Where the environmental impact potential is severe (e.g., downstream shellfish beds or drinking water intakes) a significant erosion or resuspension potential may suggest the need for quick remedial or removal action while sediment contaminants are still relatively localized and concentrated.

Our understanding of the transport of coarse-grained, noncohesive sediments is relatively well developed. Unfortunately, contaminants are most often associated with fine-grained cohesive sediments and the ability to forecast their behavior with confidence is very poor. Significant research is under way by the Army Corps of Engineers and the Environmental Protection Agency to try to define the sediment-water boundary layer conditions that limit the use of predictive models. With information concerning the strength of the currents, some general statements can be made concerning whether a site is likely to be one of scour or of deposition. However, the rates of either erosion or deposition cannot now be estimated from measured parameters. General statements are usually not an adequate basis for management decisions. A more complete understanding of the sediment transport processes for fine-grained cohesive sediments is needed.

Present practice, based on state-of-the-art knowledge, is to employ empirical models. For example, several major studies have been conducted by the Corps of Engineers for Mississippi Sound in the Gulf of Mexico, Los Angeles and Long Beach harbors, and Chesapeake Bay. These investigations have attempted to modify and adapt three-dimensional models to site-specific conditions. Resuspension rate, settling velocity, deposition rate, critical erosion velocity, rate of consolidation, rate of biological mixing, and other variables must be empirically determined for each site. The relevant processes are described by direct measurements in the field to determine a set of empirical parameters that are then applied to the site. Measured site-specific data then provide the quantitative examples that are assumed to be typical of that site at all times. Although the models rely on highly empirical approaches, they are the best tools presently available for making predictions of sediment resuspension and transport.

Empirical models for predicting the resuspension and mixing of contaminated sediments have serious limitations which include the following:

1. Relying on measurements made at a specific time and place under a particular set of conditions. There is no guarantee that the measured rates will be accurate if any of the conditions change. Small changes in the environment can lead to very large discrepancies between the empirical forecast and the actual phenomenon. As a result, the empirical models are accompanied by potentially large, and usually, unspecified uncertainties. In many cases, the magnitude of the uncertainties may be acceptable in the management decision if it is known with confidence.

2. Development of empirical models can be extremely costly. There are many types of data needed and the measurements have to be made at many locations over long time periods to improve confidence in the results. Additionally, measurements have to be made for every site of interest. This would not be a serious disadvantage if there were only a few contaminated sites. Unfortunately, there are many sites that need attention.

Recommendations

Contaminant Transport and Partitioning

Continued and expanded support should be given to understanding the partitioning of contaminants among sediments, soils, water, organisms, and the atmosphere, as well as the transport of substances in the various phases.

Research in Sediment Transport

To keep costs of modeling fine-grained sediment transport reasonable, models built on basic processes need to be developed. While empirical models continue to be used to reach management decisions, effort should be simultaneously directed to understanding the basic processes to be modeled and the validation of models in the field. Specifically, support should be expanded for research to determine the fundamental processes responsible for sediment cohesion and the factors controlling their resuspension. There is also a need to improve the reliability of estimates of both deposition and resuspension. Research programs in this area should be expanded and diversified.

Tiered Response Strategy

A tiered strategy is needed to address contaminated sediment problems in situations in which high erosion rates or resuspension potential may rapidly alter the distribution of contaminants and there is no time to carry out more detailed assessments. Problems in high-energy environments should be assessed promptly.

CONTAMINATED SEDIMENT MANAGEMENT STRATEGIES

Findings

Although the dredged material management strategy developed by the Corps of Engineers may be relevant to severely contaminated sediments, it is important from a management standpoint to differentiate them from less contaminanted sediments. In particular, most highly sophisticated remedial technologies (i.e., those involving treatment or destruction of associated contaminants) are likely to be cost-effective only in small areas and for sediments with relatively high contamination levels. Sediment contamination problems often involve large volumes of sediment with relatively low contamination levels. As a result, some highly sophisticated technologies may be inapplicable or inefficient for remediating contaminated sediments.

"No action" may be the preferred alternative in cases in which the remedy may be worse than the disease--e.g., where dredging or stabilizing contaminated sediments results in more biological damage than leaving the material in place. Contaminants generally accumulate in depositional zones, and, if the source is controlled, new sediments will deposit and cap the contaminated material over time. In effect, no action alternatives in such cases may result in natural capping.

Extensive preremediation studies, as practiced at very large sites (e.g., Commencement Bay, New Bedford Harbor, upper Hudson River) may not be practical at much smaller sites. Routine screening procedures and validated sediment assessment methods may be especially valuable in such cases. Large-scale remedial technologies are often not applicable to small sites for a variety of reasons. In such cases, regional sites or facilities may provide a means for handling sediments from several smaller sites.

There are existing management alternatives that have been effectively used for dealing with contaminated sites.

1. No action may be an acceptable option if the contamination degrades or is buried by natural deposition of clean sediment in a short period of time.
2. In-place capping may be a useful option if the sediments are not in a navigation channel or if groundwater is not flowing through the site.
3. Removal and subaqueous burial off-site may be a viable option, although the experience with this technique is limited to relatively shallow water (< 100 ft).
4. Incineration seems to be viable only for sites with relatively small amounts of sediments containing high concentrations of combustible contaminants.
5. Other techniques to assist in remediation of contaminated sediment may be appropriate in special cases. Examples include a variety of sediment stabilization or solidification techniques, and biological and/or chemical treatment.

Recommendations

Dredged Material Management Strategy

Additional evaluation should be conducted to determine the applicability of the Corps of Engineers' dredged material management strategy to more severely contaminated sediments.

No Action

No action should always be considered as an alternative strategy for minimizing biological damage. In using the no-action strategy as a form of natural capping of contaminated material, consideration should be given to the length of time it takes for contaminants to be isolated from the food chain.

REMEDIAL TECHNOLOGIES

Findings

From a remediation standpoint, the most important factors are likely to be defining of the clean-up target, technical and cost feasibility, natural recovery estimates, and ability to distinguish and/or control continuing sources of contaminants.

Dredging technology exists that is capable of greatly reducing turbidity and resuspension in connection with dredging of bottom sediments in most applications. However, because of legal (i.e., Jones Act) and practical restrictions that limit access to foreign-built vessels domestically, it may be difficult to secure access to this technology in the United States--except as equipment fitted onto U.S.-built vessels or supplied through U.S. subsidiaries of foreign dredging companies. U.S. government policies have not provided adequate encouragement to domestic firms to construct innovative dredges.

Although silt curtains can prevent movement of sediment in the top two or three feet of water column, they allow movement of sediment under the silt curtain. Silt curtains cannot operate with currents faster than one knot and are ineffective in waves. Thus, the use of the silt curtains is contined to low-energy areas.

Capping of contaminated sediments--whether in place, as mounds, or in subaqueous pits--in many cases offers a promising means of effectively isolating and containing associated contaminants. A potentially significant legal and policy issue is whether capping with clean sediments is to be deemed a preferred treatment approach under SARA, Section 121(b). On the one hand, capping can be done on site (which is favored over offsite transport) and it can "significantly reduce the . . . mobility of the hazardous substances, pollutants, and contaminants" present. On the other hand, it is not treatment in the usual chemical, biological, or physical sense, but rather containment or permanent storage. If capping materials are modified with the addition of carbon or other materials they may sorb contaminants and thus could more reasonably be defined as a treatment alternative.

While widely applicable, there are practical limits to the feasibility of capping. Among the factors that may preclude or constrain the use of capping are water depth; low sediment density; high sediment water content; active erosional area; active navigational channel requiring periodic maintenance dredging; and the use of trawls, draglines, or oyster dredges, which would destroy the integrity of the cap. Although the sediment properties needed for an effective cap are not well-defined, both clay and sand have been used successfully. Attention must also be paid to any subsequent disturbance of the cap either by natural processes (e.g., storm erosion or bioturbation) or human activity (e.g., fishing).

There are several examples of capping of dredged sediment mounds on subaqueous disposal sites. These provide very useful experience for guiding future decisions. There are, however, few general standard criteria for evaluating the likely success of a planned capping operation. Where capping is clearly feasible, prudence (and/or SARA) may dictate well-directed monitoring. Such monitoring can constitute a significant proportion of the total remedial action cost.

Recommendations

Source Control

Source control measures must be considered in all cases, including no action. Federal and state regulatory agencies requiring remedial action should implement source control measures as a component of remedial action when applicable and appropriate. Use of financial incentives through strict liability for assessment costs, remedial actions, and damages also may play an important role in source control, provided that trustees make aggressive efforts to hold responsible parties liable for releases into the environment.

Technology and Information Transfer

Aggressive technology and information transfer mechanisms are needed to ensure that knowledge gained and lessons learned from all remedial actions are available and accessible to managers confronting new remediation problems at federal, regional, and local levels. Knowledge gained should be systematically compiled in guidance documents. Lessons learned regarding the feasibility of sophisticated remedial technologies under varying conditions of contamination severity and extent should be documented and made widely available to facilitate future decision making. Lastly, experience gained through the use of screening procedures at large sites should be distilled and generalized into routine methodologies for economically assessing smaller sites.

Remediation and Navigational Dredging

When possible, remediation projects should be designed to take advantage of existing navigational dredging activities that may already be authorized in conjunction with the Clean Water Act, Section 115 or Section 10/404.

Remedial Technologies

Research and development should be encouraged by the federal government to develop technology and equipment for efficiently removing contaminated sediments and to make it available in the United States. Foreign technologies should continue to be examined relative to their appropriateness in this country. Efforts to conduct and fund research and development as a partnership between government and industry should be encouraged.

Use of Capping

Although capping might not, in the strictest terms, be considered a remedial technology, it should not be ignored because it can play a valuable role in remediating contaminated sites.

Well-focused Monitoring

Monitoring programs should be well-focused on testing forecasts made during design of the remediation plan. To the extent possible, monitoring should be extended to remove uncertainties in the basic understanding of contaminated sediment behavior. For example, monitoring of capped areas might focus on changes of cap thickness, erosion around boundaries, and leakage of contaminants through the cap.

REMEDIATION AND SOURCE CONTROL: ECONOMIC CONSIDERATIONS

Findings

Remedial actions are costly and become more expensive as additional levels of clean-up or treatment are pursued. The role of tradeoffs between possible technologies at and among sites must be considered, given the scarcity of funds to clean up contaminated sites and the potentially great number of sites.

The use of benefit-cost analysis as part of the remedial action decision process would provide perspective on the issues involved. It would place investments in this area on the same footing as other public investments. However, difficulty in quantifying benefits from remedial actions in monetary terms makes reliance on benefit-cost analysis infeasible in a number of cases. Nonetheless, in light of the high cost of remedial actions, it is important that implicit (if not explicit) consideration be given to potential benefits before remedial actions are undertaken.

Cost-effectiveness analysis is also a valuable technique for helping to guide clean-up efforts at and among sites when a decision to remediate has been made. However, to be applied correctly, both short- and long-term costs must be included, and costs must be estimated consistently for alternative actions at and among sites.

The process of assessing the need for remediation and evaluating alternative remedial actions for a site appears to be excessively long and costly. In many cases, millions of dollars and several years are expended before a decision is made. If remedial action is excessively delayed, benefits may diminish over time.

Removal of contaminated sediments can be very expensive, varying widely from several hundred thousand dollars to tens of millions of dollars. Data on 15 clean-up sites indicate that total clean-up costs can reach \$500,000 to \$1,000,000 per acre.[1,2] This compares with

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[1]For purposes of comparison, assume that a one-acre cleanup involved removing overburden to a depth of one yard, or a total of 43,560 yds^3 of contaminated material. In that event, total cleanup costs would range from \$11.50 to \$23.00 per yd^3.

[2]U.S. Congress Office of Technology Assessment. 1988. Are we cleaning up? 10 Superfund case studies. Special Report OTA-ITE-362. Washington, D.C.: U.S. Government Printing Office.

an average unit cost of navigation dredging of $1 to $2 per cubic yard of sediment dredged. The average unit cost of all dredging, both government and private, is estimated at $1.67 per cubic yard of material dredged.[3] Onsite incineration, one of the remedial measures proposed at various sites, is also very expensive. The estimates quoted are from $186 to $750 per cubic yard.[4]

Recommendations

Use of Benefit-Cost Comparisons

In view of the high cost of remedial actions in most cases, greater use should be made of benefit-cost comparisons over ecologically relevant time periods in order to place investments in this area on the same economic footing as investments in other public projects.

Cost-Effectiveness Analysis

Cost-effectiveness analysis of alternative remedial actions should consider both short- and long-term costs. Comparisons at and among sites should be based on costs estimated using a consistent approach.

Degree of Remediation

In evaluating the degree of remediation to be conducted at a site, it should be recognized that incremental costs typically will increase rapidly as additional levels of clean-up are sought.

Economic and Environmental Considerations

The decision as to whether or not remedial actions are undertaken should be based on a balanced comparison of the anticipated environmental and public health benefits of actions with their costs, including possible environmental and health risks.

Infeasible Remedial Options

Clearly infeasible options should be eliminated at the outset, before alternative remedial actions are considered in depth.

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[3]Pequegnat, W.E. 1987. Relationship between dredged material and toxicity. TERRA et AQUA 34.

[4]Op. cit., no. 1.